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ABSTRACT

This unit of instruction on citrus production was designed for use by agribusiness and natural resources teachers in Florida high schools and by agricultural extension agents as they work with adults and students. It is one of a series of 11 instructional units (see note) written to help teachers and agents to educate their students and clients about the problems of energy shortages and strategies for energy conservation and management. This unit is organized into nine modules. Topics covered in the unit include energy usage, site planning, planting, grove operations, integrated pest management, fertilization, irrigation, cold protection, and harvesting and hauling the citrus crop. The unit contains student performance objectives, content information, teaching-learning activities, student handouts, transparency masters, and evaluation instruments. (KC)

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ED210535

LOW ENERGY TECHNOLOGY

A UNIT OF INSTRUCTION

IN

CITRUS PRODUCTION

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Developed by

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Department of Agricultural and Extension Education
Department of Fruit Crops
Lake Alfred Research and Education Center
Institute of Food and Agricultural Sciences
University of Florida
Gainesville

1981

This public document was promulgated at a cost of $219.57, or 87¢ per copy to inform teachers, county extension personnel, students and citrus producers on low energy technology in citrus production.

This unit of instruction was developed as a part of the Low Energy Technology Program of the Institute of Food and Agricultural Sciences, University of Florida. Additional copies of this and other units of instruction in Low Energy Technology can be obtained by contacting the Instructional Materials Service, 101 Rolfs Hall, University of Florida, Gainesville, Florida 32611.

CE 030 827

INTRODUCTION

The energy crisis which Americans have and will continue to experience requires efforts by all of us to make more efficient use of our energy resources. As energy sources dwindle, supplies decrease and prices increase, consumers are faced with difficult decisions regarding their personal consumption of energy and the impact the energy problem will have on their lives.

This unit of instruction deals with energy saving ideas for the citrus grower. It emphasizes effective ways to save energy and valuable resources. Minimizing the cost and quantity of inputs will maximize return of profits to the grower. There are nine main topics in this unit of instruction on Citrus Production with many different student performance objectives:

1. Energy Usage - pages 1-16
2. Site Planning - pages 17-24
3. Planting - pages 25-27
4. Grove Operations - pages 28-37
5. Integrated Pest Management - pages 38-48
6. Fertilization - pages 49-51
7. Irrigation - pages 52-59
8. Cold Protection - pages 60-73
9. Harvesting and Hauling - pages 74-76

There are several suggested teaching-learning activities for each objective. It is recommended that all activities, when possible, be included in the instruction of this unit. The topics were sequenced in a logical order; however, we strongly suggest that the teacher select those teaching-learning activities most appropriate for the students or adults in the group and with which the teacher feels competent and comfortable.

Included in this unit of instruction are student performance objectives, content information, teaching-learning activities, student handouts, transparency masters and evaluation instruments.

This unit of instruction was designed for use by agribusiness and natural resources education teachers in Florida high schools and for agricultural extension agents as they work with youth and adults.

Special appreciation goes to the following members of the Lake Alfred Research and Education Staff: Dr. Dave Tucker, Dr. W. S. Castle, Dr. DuCharme, Dr. J. L. Knapp, Dr. G. E. Coppock and Dr. L. R. Parsons for their technical assistance in developing this module.

This unit of instruction was developed by the Department of Agricultural and Extension Education, Department of Fruit Crops and the Institute of Food and Agricultural Sciences, University of Florida as part of their Low Energy Technology Program.

UNIT: CITRUS PRODUCTION

MODULE: ENERGY USAGE

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Identify six factors influencing the energy used in Florida Citrus Production.	Florida Citrus Production Energy Use (1977-78) -irrigation and drainage, 32.5% -cold protection, 21.9% -harvest and hauling, 19.0% -spraying and dusting, 7.2% -tree replacement, 6.0% -transportation, 5.4% -other uses, 7.9%	Read: Citrus Energy Use and Conservation, EI-47. Florida Citrus Energy Survey. Show Transparancy: "Florida Citrus Energy Use". Discuss contributing influences to the percentage of usage in each factor with the class. Brainstorm ideas which could save energy. Evaluation: Given a blank pie graph students should be able to complete the energy use factors for Florida Citrus Production Energy Use for 1977-78 with 80% correct.

Energy Information Fact Sheet
May 1980

EI-47

Citrus Energy Use and Conservation

Citrus Energy Use and Conservation

Florida Cooperative Extension Service/Institute of Food and Agricultural Sciences/University of Florida/J. T. Woeste, Dean

With the increasing cost and potential shortage of fuel, growers are becoming concerned about energy requirements for the production of citrus. This fact sheet presents a summary of an energy use survey for the 1977-78 crop year.* Included in this fact sheet are estimates of the direct annual energy consumption for producing, harvesting and hauling fruit for the various operations. The indirect energy invested in machines, fertilizer, lime and pesticides is not included. In addition, recommendations for conserving energy in citrus production are offered.

The estimated annual fuel consumption for producing and harvesting the 850,000 acres of citrus in Florida was equivalent to 83 million gallons of diesel fuel, or about 97 gallons per acre. The energy intensiveness of various operations is shown in Figure 1.

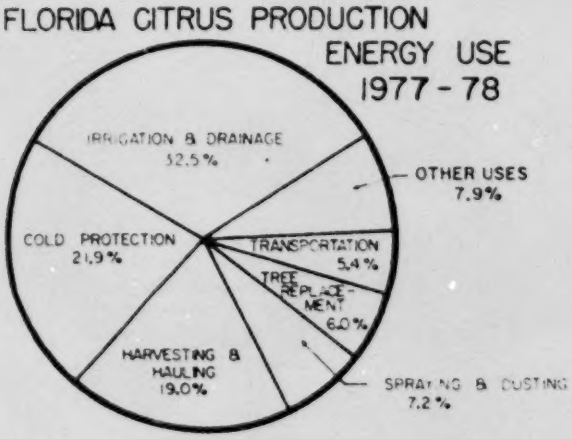


Figure 1.

IRRIGATION

Irrigating an estimated 530,000 acres (62 percent) of the citrus crop consumed about 32 percent of the total energy used in citrus groves, more energy than was used in any other operation. Irrigation pumping systems require large energy inputs because in most cases, water must be lifted to field elevations from wells or surface water sources. Energy is also needed to distribute the water through a network of pipes and applicators such as impulse sprinklers and/or nozzles.

Irrigation Systems

The energy requirements, expressed in diesel fuel equivalents, for pumping are shown in Table 1.

Table 1. Irrigation Systems—Energy Requirements

System	RIDGE AREAS		INDIAN RIVER AND FLATWOODS	
	Water Application (inches)	Diesel Fuel Requirements (gal/acre)	Water Application (inches)	Diesel Fuel Requirements (gal/acre)
Guns	22.5	117	17	76
Overhead	24.0	87	18	52
Perforated Pipe	24.0	45	18	21
Low Volume	10.0	19	6	7
Seepage	–	–	27	4

From this table it can be seen that energy requirements vary widely depending on the type of system used. When planning to irrigate additional acreage, or when replacing existing systems, special consideration should be given to irrigation systems with lower fuel requirements, specifically, seepage, low volume and perforated pipe systems.

Some advantages and disadvantages of the most commonly used systems can be briefly compared:

1. High pressure guns—These systems are large energy users; however, they are versatile and can be adapted for use in oddly-shaped groves. Application efficiency is about 80 percent.
2. Permanent overhead sprinklers—These systems are medium range energy users. They can be designed to provide frost protection for nurseries and newly planted groves. Application efficiency is about 75 percent.
3. Drip and low volume—These systems conserve energy and water. Because water is applied near the soil surface, less evaporation occurs and more water is stored in the root zone. Clogging problems sometimes are severe and water must then be filtered and/or chlorinated. Application efficiency is about 85 percent.

*This survey was conducted by the Institute of Food and Agricultural Sciences in cooperation with the Governor's Energy Office. The complete survey is reported in the IFAS publication, Citrus Energy Survey—Use Estimates and Conservation, by J. M. Stanley, C. Taylor, W. K. Summerhill, and L. J. Beaulieu.

CITRUS IRRIGATION SYSTEMS

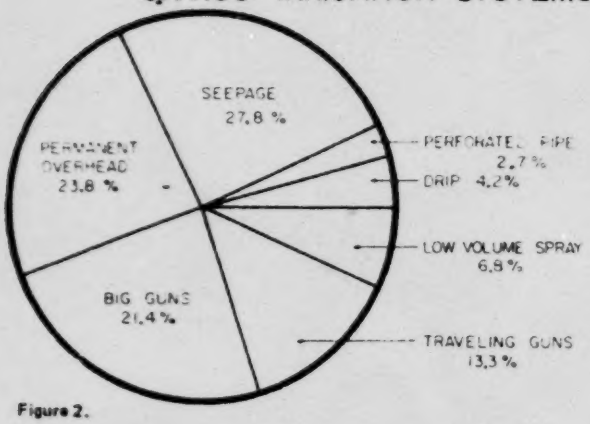


Figure 2.

4. Seepage—This type of irrigation has low energy requirements. However, it is limited in use to soils with either high water tables or restrictive soil layers right below the citrus root zone. Large quantities of water must be pumped to maintain a water table at the proper level while irrigating. Application efficiency is about 50 percent.

Fuels for Pumping

The survey found energy sources used in pumping water to be broken down as follows: diesel fuel, 59 percent; electricity, 37 percent; LP gas, 2.3 percent; and gasoline, 1.7 percent. Diesel is popular because of its high energy value per gallon and its availability as compared with other fuels. In spite of this, the cost of a diesel power unit is greater than that of other internal combustion engines.

When purchasing an irrigation system, consider efficiency and availability of fuel as well as cost and longevity. A sound machinery maintenance program is essential for conserving energy. Proper adjustment of pumps, power units, and distribution systems can significantly increase the energy efficiency of every irrigation system.

Water Management Techniques

Irrigation has proven beneficial to growers by increasing yields. Well-timed watering, and watering in the proper amounts, will conserve fuel and water. Also, efficient watering is important from a regulatory viewpoint for an adequate supply of water to be available for all citizens.

Depending on air temperature, relative humidity, day length and other factors, different amounts of water are taken up by trees daily. Yearly, 42 to 48 inches of water are lost through evapo-transpiration. Irrigation should be scheduled when 50 to 75 percent of the available water in the root zone has been depleted.

Each grove has different usable soil water-storage capacities, depending on the soil type. Consider the soil's water-retaining and percolating characteristics, depths to clay and the water table and rooting depths in determining your soil's water-storage capacity. Know your grove's usable soil moisture capacity in inches.

To determine when to irrigate, either:

1. Measure soil moisture with a soil tensiometer; or
2. Use the accounting method to keep track of soil moisture.

The Accounting Method. Starting with soil at full water-storage capacity, subtract the average daily rate of water use (citrus use ranges from a minimum of 0.08 inches in January to a maximum of 0.20 inches daily in May through September) until a selected lower limit is reached. This limit should occur when 50 to 75 percent of the water is depleted from the soil. Then, irrigate unless rainfall occurs in sufficient quantities to satisfy citrus water demand.

Frequency of irrigation should equal usable soil moisture in inches divided by the high daily water use; this frequency tells how many days should elapse between irrigations. For best results, be sure to irrigate in spring, from January to June. Consult your county agent for your individual irrigation program.

How Much To Apply? Work at the Citrus Experiment Station has shown that 4 to 9 2-inch irrigations per year are desirable. In Flatwood soils, applications of only 1 to 1½ inches are recommended because of the restricted root zones. Variations in how much to apply depend on rainfall, soil type, and variety and rootstock of citrus.

References

For more information on irrigating efficiently, refer to the following publications:

1. Dalton S. Harrison, *Energy Management in Irrigation*, IFAS Energy Information Fact Sheet 12.
2. R. E. Choate and D. S. Harrison, *Irrigate by the Accounting Method*, IFAS Circular 431.
3. D. S. Harrison and R. C. J. Koo, *Irrigation Methods and Equipment for Producing Citrus in Florida*, IFAS Water Resources Council Fact Sheet 10.
4. Herman J. Reitz, et al. *Water Requirements for Citrus*, IFAS Water Resources Council Fact Sheet 4.

COLD PROTECTION

Cold protection required about 22 percent of the energy consumed in 1977-78. This period was not as cold as the preceding year, but it was colder than the 1978-79 season. The fuel requirements for heating an average of 3.5 nights (6 hours per night) by the various systems were as follows:

	Heaters	Wind Machines	Combination Wind Machines and Heaters
Acres	23,000	18,000	3,500
Gallons of Fuel per acre	735 (diesel)	11 (gasoline)	11 (gasoline) and 315 (diesel)

Growers are leaning toward the protection of trees rather than fruit, which means that they are not applying heat until the temperature reaches a lower level than was formerly used as a guide. The use of wind machines in combination with heaters offers an opportunity to conserve fuel, as shown. Along with improved techniques for weather prediction from satellite equipment, warning systems are being developed to inform growers of extreme conditions requiring heating.

Some "passive" freeze protection techniques are also helpful in moderating the effects of severe weather. These practices include:

1. Keeping a clean orchard floor to maximize heat entry into soil during the day. At night, this heat is released, raising the grove temperature a few degrees.
2. Banking young trees to keep the trunk and root system alive. Tree wraps are also useful.
3. Irrigating a few days before a cold front is expected.
4. Pruning late in spring to keep fuller leaf on trees during winter.
5. Choosing hardy varieties which can withstand cold.
6. Selecting sites with slopes or downwind from bodies of water and as far south as possible.

References

For more information on low-energy cold protection, see the following:

1. Jon Bartholic and Larry Jackson, *Energy Saving Ideas for Orchard Cold Protection*, IFAS Energy Information Fact Sheet 22.
2. Jon Bartholic, *Passive Freeze Protection Suggestions for Your Orchard*, IFAS Energy Information Fact Sheet 23.

HARVESTING FRUIT

Harvesting operations included the moving of fruit out of the grove (roadsiding), transporting picking crews and hauling fruit to a processing plant or packing house. These tasks required 19 percent of the total energy.

Roadsiding, with gasoline-powered vehicles in most instances, used an estimated 3.7 gallons of gasoline per vehicle per acre for the season. Good management is essential as in other operations. For example, hauling full loads of fruit by direct routes to loading points will save fuel. Keeping equipment in good operating condition provides additional opportunities for fuel economy.

Transporting picking crews required an estimated 8.3 gallons of gasoline per acre. Careful attention to route planning can reduce this fuel use. When possible, hire pickers based near groves.

Hauling fruit to the processing plant or packing house required an estimated 7.7 gallons of diesel fuel per acre. Hauling over as little distance as is conveniently possible and reduced cross-hauling can minimize this energy use.

All vehicles used should have properly tuned engines and should be maintained in overall good condition.

SPRAYING AND DUSTING

Spraying and dusting consumed 7.2 percent of the energy. The breakdown for the percentage of acres treated by various methods is shown in Figure 3, and the fuel requirements per acre for different techniques are shown in Figure 4. Figure

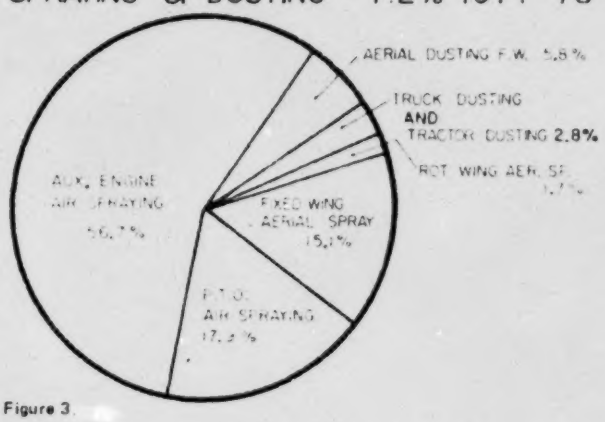

SPRAYING & DUSTING - 7.2% 1977-78
AERIAL DUSTING F.W. 5.8%
TRUCK DUSTING AND TRACTOR DUSTING 2.8%
ROT. WING AER. SP. 1.7%
AUX. ENGINE AIR SPRAYING 56.7%
FIXED WING AERIAL SPRAY 15.1%
P.T.O. AIR SPRAYING 17.2%

Figure 3.

3 shows that auxiliary engine air-spraying equipment was used in treating almost 57 percent of the acreage. This equipment required the largest amount of fuel, 2.5 gallons of diesel fuel per acre. Fuel use for both the auxiliary engine and the tractor to pull the sprayer was considered. The power take-off operated sprayer requires less fuel per acre. The use of concentrated sprays will also result in lower energy use since less water has to be hauled through the grove and sprayed on the trees.

Aerial application consumes less fuel per acre and provides faster coverage than ground equipment.

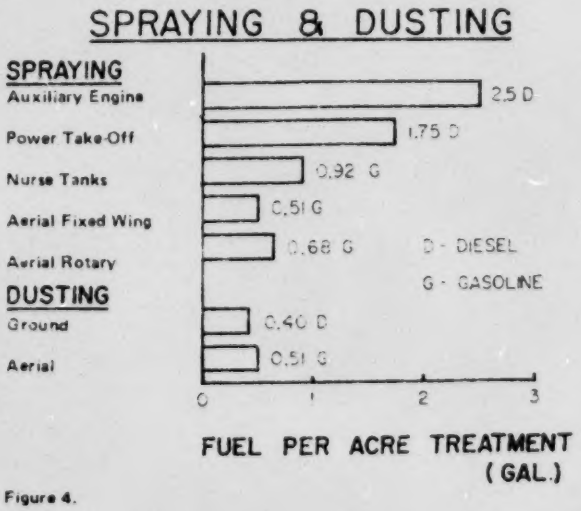


Figure 4.

TREE REMOVAL AND REPLACEMENT

Tree removal and replacement required an estimated 6 percent of the energy used. Tree replacement is necessary in order to keep acreage at top production efficiency. An unproductive vacant spot will normally receive the same cultivation, fertilization and irrigation as a mature tree. To conserve energy and increase output, a new tree should be planted.

A reset requires frequent watering in addition to regular irrigation. Trips must also be made for additional fertilization. The 2.5 average of replaced trees per acre will normally require travel over the entire grove. A management system to minimize travel is difficult but desirable to conserve energy.

TRANSPORTATION

A little over 5 percent of energy used in citrus production was estimated to be for transportation. Fuel consumption of vehicles was as follows: cars, 540,000 gallons of gasoline; pickups, 3,600,000 gallons of gasoline; trucks, 430,000 gallons of gasoline; and transports, 360,000 gallons of diesel. Combining trips to oversee operations, or any other reduction in travel that can be accomplished is an opportunity to conserve fuel.

OTHER ACTIVITIES

Other grove maintenance activities were also energy consuming. Weed control required an estimated 3.4 percent of total energy use. Reduction in the frequency of mechanical weed control procedures will reduce energy use.

Hedging and topping used about 1.7 percent of the total energy. In general, more frequent trimming of small limbs will use less energy than removing large tree limbs with heavy equipment. Once again, a good maintenance program will conserve energy and reduce the costs of producing.

Fertilization required less than 1 percent of the total energy. Most growers used 2 applications. There is little difference in the energy requirements for applying dry and liquid fertilizer, but high analysis materials which reduce the volume hauled and spread will reduce energy use.

Drainage required 0.3 percent of the energy used for citrus production.

ADDITIONAL REFERENCES

1. L. K. Jackson, *Energy Saving Tips for Growing Florida Citrus*, IFAS Fruit Crops Fact Sheet 48.
2. Richard P. Cromwell, *Citrus Grower's Guide to Spraying*, IFAS Circular 351.
3. Dalton S. Harrison and Rush E. Choate, *Selection of Pumps and Power Units for Irrigation Systems in Florida*, IFAS Circular 330.

To obtain copies of the publications cited or for more information about energy conservation, contact the Energy Extension Service of your county Extension office.

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF FLORIDA, INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES, K. R. Tefertiller, director, in cooperation with the United States Department of Agriculture, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and is authorized to provide research, educational information and other services only to individuals and institutions that function without regard to race, color, sex or national origin. Single copies of Extension publications (excluding 4-H and Youth publications) are available free to Florida residents from County Extension Offices. Information on bulk rates or copies for out-of-state purchasers is available from C. M. Hinton, Publications Distribution Center, IFAS Building 664, University of Florida, Gainesville, Florida 32611. Before publicizing this publication, editors should contact this address to determine availability.

FLORIDA CITRUS ENERGY SURVEY[1/2/]

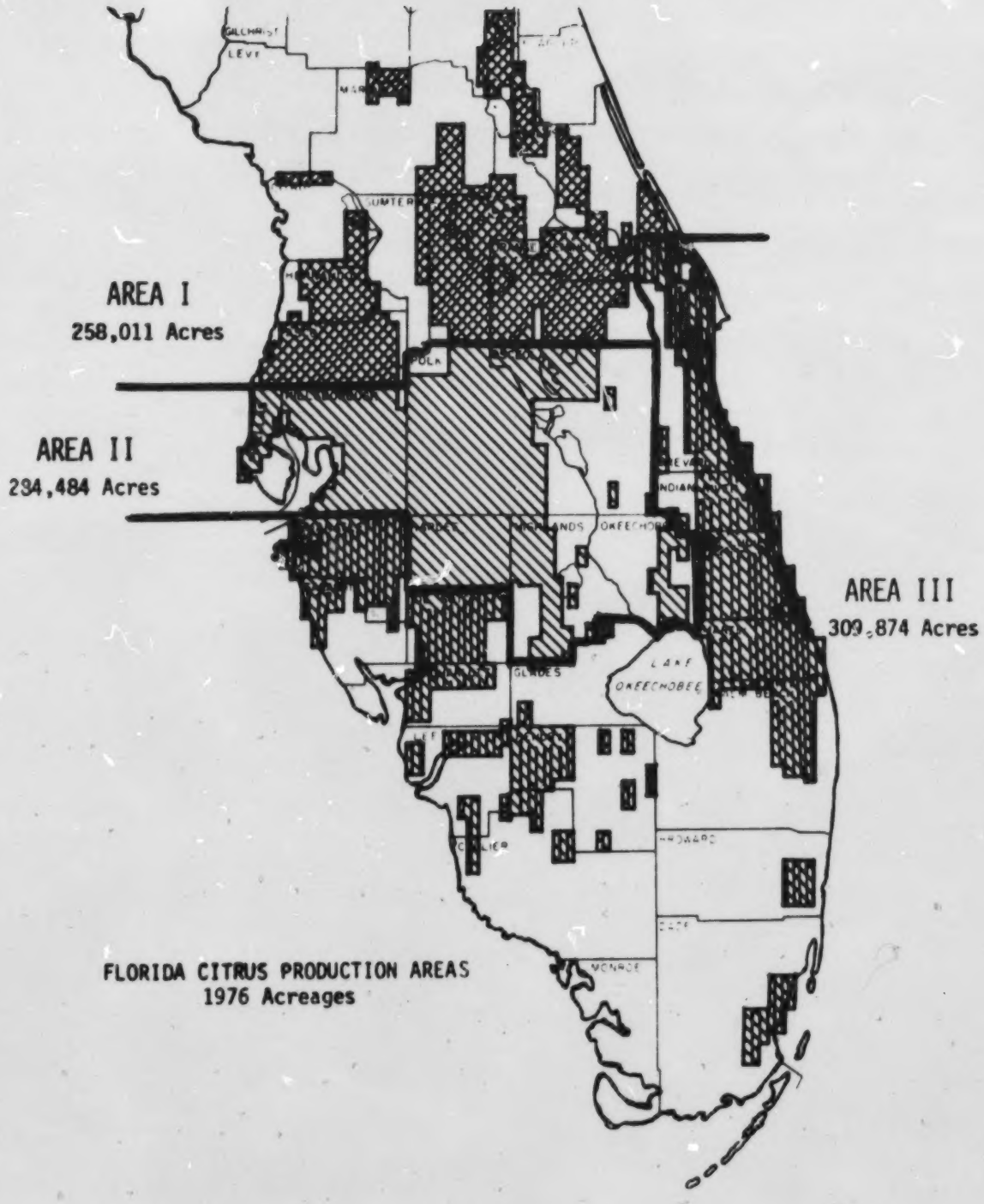
SEPTEMBER 1979

James M. Stanley
Visiting Professor
Agricultural Engineering Department, IFAS
University of Florida

[1/] This survey was conducted as part of an Agricultural Energy Conservation Project in cooperation with the Governor's Energy Office.

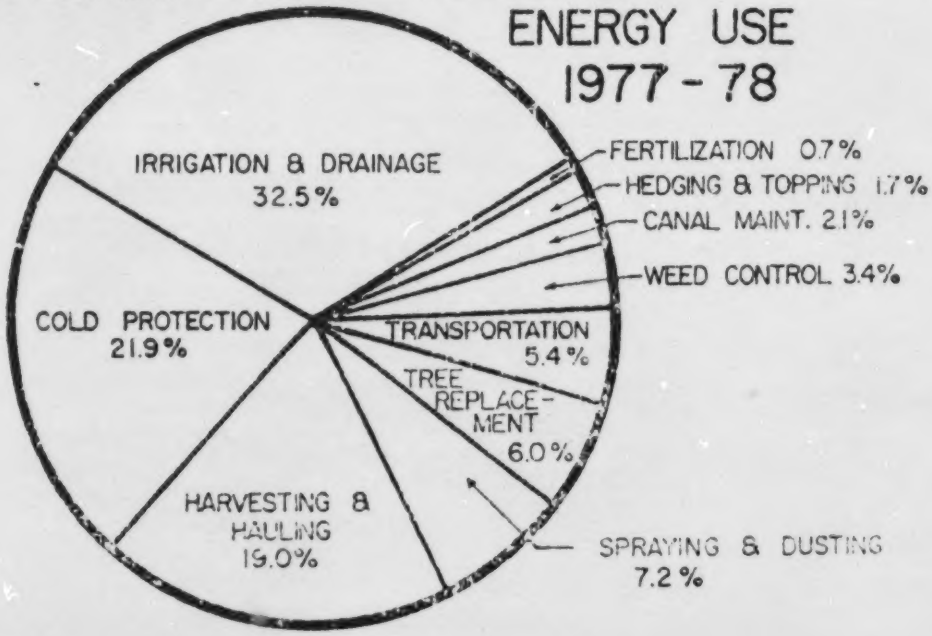
[2/] Includes estimates on direct annual energy consumption for producing, harvesting and hauling fruit. Energy invested in machines, fertilizer, lime and pesticides not included.

January 1980



FLORIDA CITRUS PRODUCTION AREAS
1976 Acreages

FLORIDA CITRUS PRODUCTION ENERGY USE 1977 - 78



CITRUS IRRIGATION 32.5%

1977-78

	ACRES	PERCENT
AREA I	83,811	32.5
AREA II	157,041	55.2
AREA III	288,907	93.2
STATE	529,759	62.2

1/ Percent of total acres

IRRIGATION SYSTEMS - ENERGY REQUIREMENTS

RIDGE AREAS

System	Water [1] (in.)	TDH [2] (ft.)	Diesel Fuel [3] (gal./acre)
Guns	22.5	360	117
Overhead	24.0	250	87
Perf. Pipe	24.0	130	45
Low Vol.	10.0	130	19

IRRIGATION SYSTEMS - ENERGY REQUIREMENTS

INDIAN RIVER & FLATWOODS

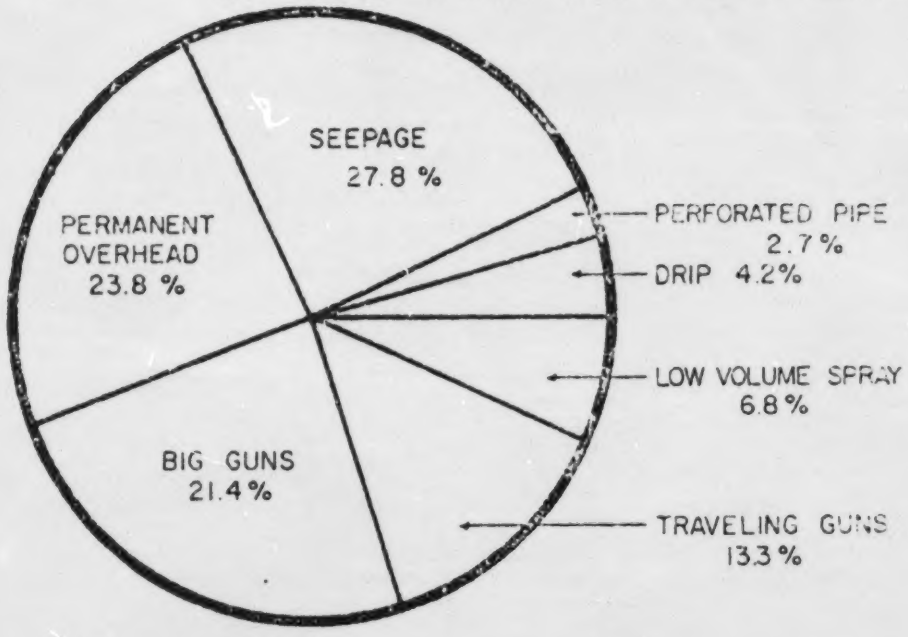
System	Water [1] (in.)	TDH [2] (ft.)	Diesel Fuel [3] (gal./acre)
Guns	17	310	76
Overhead	18	200	52
Perf. Pipe	18	80	21
Low Vol.	6	80	7
Seepage	27	10	4

[1] Application rates are maximum gross amounts taken from "Irrigation Methods and Equipment for Production of Citrus in Florida," IFAS, WRC-10, with application efficiencies from "Water Requirements for Citrus," IFAS, WRC-4 applied.

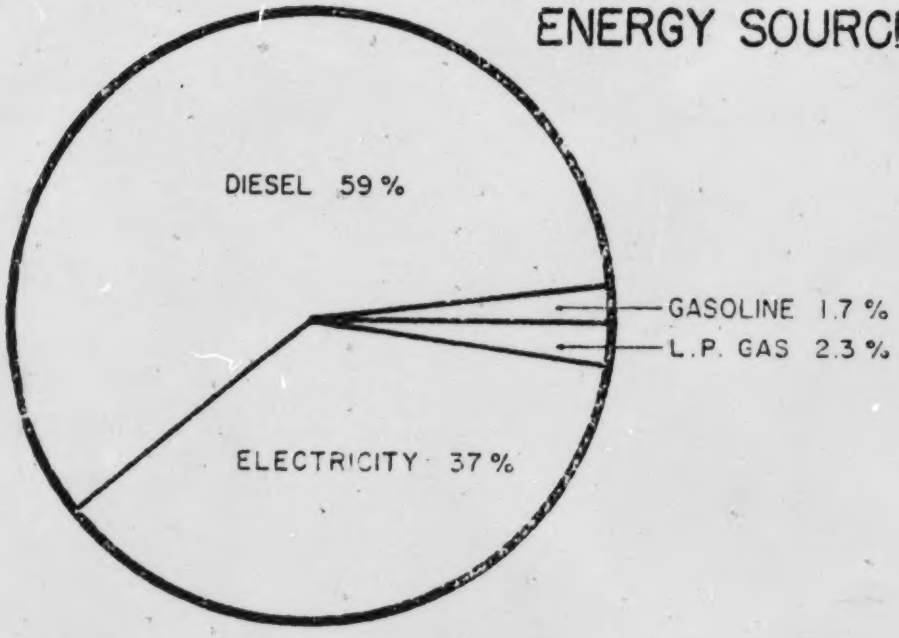
[2] Total dynamic head values estimated by personnel in Agricultural Engineering Department, IFAS.

[3] Fuel requirement - 0.1752 gal. diesel fuel per acre foot per foot head (65% pump efficiency) - "Energy and U.S. Agriculture: Irrigation Pumping, 1974." USDA-AE report no. 376.

CITRUS IRRIGATION SYSTEMS



CITRUS IRRIGATION – ENERGY SOURCE



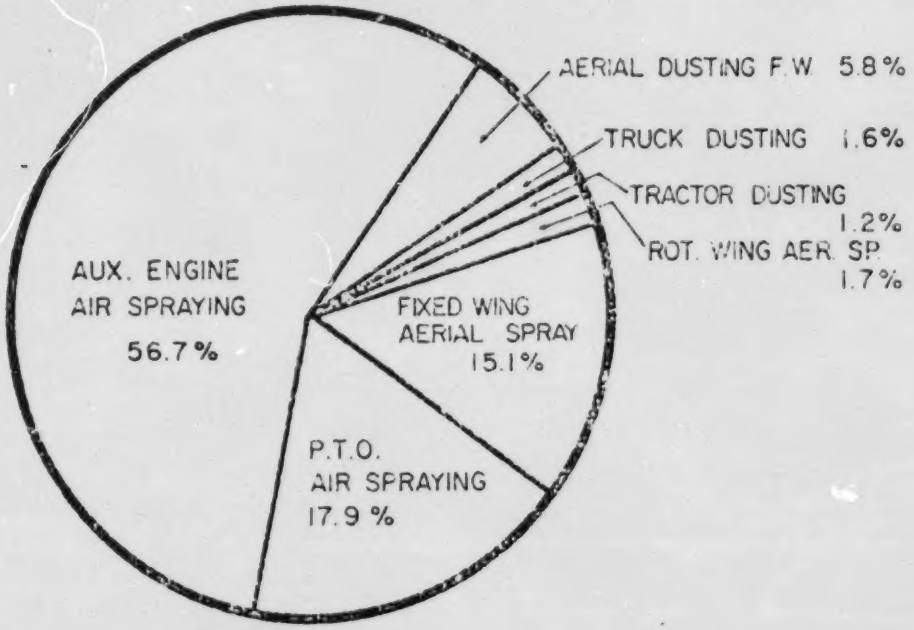
COLD PROTECTION 21.9%
1977 - 78 Av. 3.5 Nights

System	Acres (1000)	Fuel/Acre (Gal.)
Heaters	23	735 Diesel
Wind Machine	18	11 Gasoline
Combination		
Wind Machine	3.5	11 Gasoline
Heaters		315 Diesel
Damp Soil	104	Part of Irrigation

HARVESTING FRUIT 19%

Operation	Fuel (Gal.)		
	Total	Type	Per Acre
Roadsiding	3.1 M	Gasoline	3.7
Picking Crews	7.1 M	Gasoline	8.3
Hauling	6.6 M	Diesel	7.7

SPRAYING & DUSTING - 7.2% 1977-78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FIXED WING AERIAL SPRAY 15.1%
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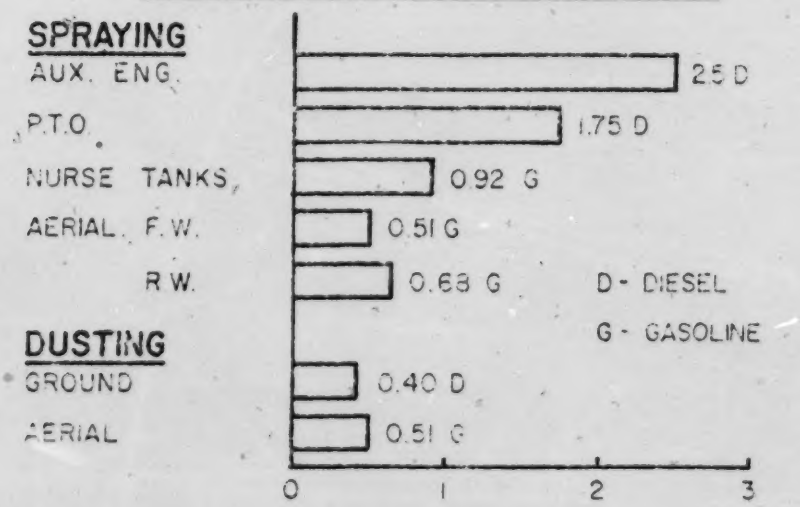
SPRAYING & DUSTING



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TREE REMOVAL & REPLACEMENT 6%

Acres: 816,974 @ 2.5 Trees/Ac.

Operation	Gal. Fuel/Ac. Diesel	Gasoline
Removal	2.3	
Tree Burning	1.4	
Site Prep.	1.1	
Watering		1.0
Fertilizing	.4	

TRANSPORTATION * 5.4%

Cars	540,000	Gal. Gasoline
Pickups	3,600,000	Gal. Gasoline
Trucks	430,000	Gal. Gasoline
Transports	360,000	Gal. Diesel

* Does not include vehicle use in production or fruit hauling operations.

WEED CONTROL 3.4%

Operation	Acres (1000)	Times	Diesel/Ac · Op (Gal.)
Mowing	419[1/]	3.8	0.63
Disking	789[1/]	2.9	0.46
Chopping	477[1/]	1.6	0.53
Herbicide	496	1.2	0.45

1/ includes cross row operation

CANAL MAINTENANCE 2.1%

Operation	Acres (1000)	Fuel/Ac. (Gal.)
Canal Cleaning	5.0	300 Diesel 60 Gasoline
Spraying		
Helicopter	9.0[1/]	0.51 Gasoline
Tractor Equip.	2.4[1/]	0.50 Diesel

1/ 1.5 applications per year

HEDGING & TOPPING 1.7%

Operation	Acres (1000)	Diesel/Appl. (Gal.)
Hedging	357	1.19
Topping	111	2.37
Brush Handling Extra Mowing	234	0.60
Heavy Equipment	116	5.00

FERTILIZATION 0.7%

Operation	Acres (1000)	Diesel/Appl. (Gal.)
Dry Fert.	683	.23
Liquid Fert.	236	.21
Lime	292	.23

CITRUS PRODUCTION - ANNUAL ENERGY USE

1977-78

ENERGY SOURCE	QUANTITY (Million)	UNIT
Diesel Fuel	61.2	Gals.
Gasoline	19.0	Gals.
L-P Gas	3.2	Gals.
Electricity	97.0	kW · h

ESTIMATED ENERGY REQUIREMENTS

1977-78

BTU Value = 11,508.98 Billion

Deisel Equivalent = 82.92 Million Gallons

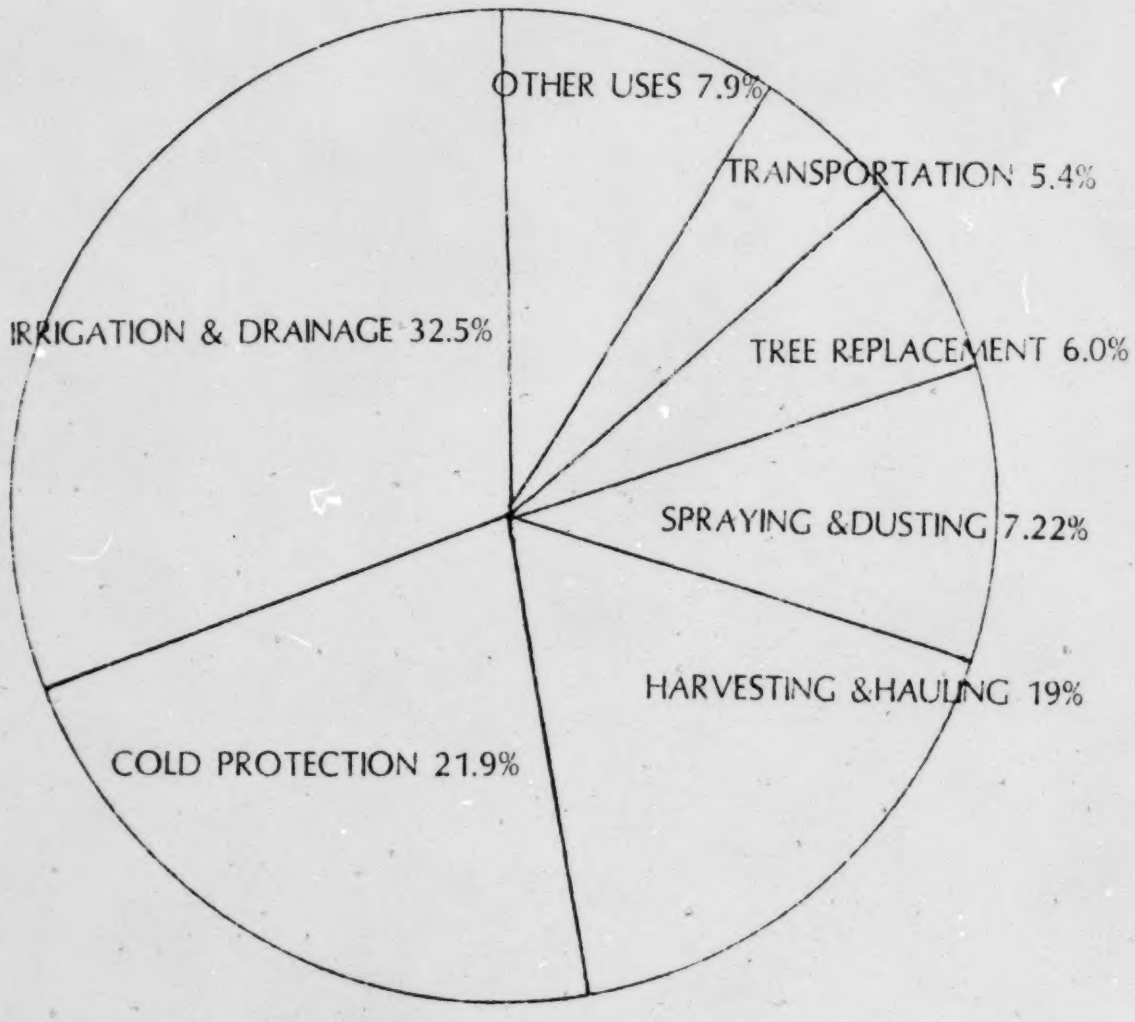
97.3 Gallons per Acre

TABLE 1 - Estimates on Percentage of Energy Requirements per Operation, on Acres Involved and on Diesel Equivalent per Acre for the Three Areas and the State.

Operation	Area I (258,011 Ac.)			Area II (284,484 Ac.)			Area III (309,874 Ac.)			State (852,369 Ac.)		
	%	Ac.	Diesel/Ac. (Gal.)	%	Ac.	Diesel/Ac. (Gal.)	%	Ac.	Diesel/Ac. (Gal.)	%	Ac.	Diesel/Ac. (Gal.)
Mowing [1/]	0.4	45,930	1.96	0.3	33,568	2.41	3.2	339,433	2.46	1.2	418,931	2.40
Disking [1/]	2.5	388,564	1.60	1.4	361,294	1.23	0.1	39,660	0.68	1.3	789,518	1.39
Chopping [1/]	0.5	130,811	0.94	0.7	273,104	0.86	0.2	73,435	0.81	0.5	477,350	0.88
Herbicide Appl.	0.2	84,627	0.67	0.4	163,863	0.74	0.6	247,878	0.62	0.4	496,368	0.67
Spraying & Dusting	9.5	258,011	9.34	6.6	284,484	7.30	5.8	309,874	4.93	7.2	852,369	6.99
Fertilizer and Lime Applications	0.6	258,011	0.62	0.6	284,484	0.65	0.8	309,874	0.67	0.7	852,369	0.65
Irrigation	22.7	83,811	68.32	29.1	157,041	58.10	44.8	288,907	40.87	32.2	529,759	50.32
Drainage	--	--	--	--	--	--	1.0	65,074	3.93	0.3	65,074	3.93
Canal Maintenance	--	--	--	--	--	--	6.7	15,000	118.53	2.1	15,000	118.53
Harvesting	3.4	258,011	3.30	3.0	284,484	3.30	3.9	309,874	3.30	3.4	852,369	3.30
Picking Crew Transportation	7.7	258,011	7.50	6.8	284,484	7.50	8.8	309,874	7.50	7.7	852,369	7.50
Hauling	5.8	258,011	5.66	7.6	284,484	8.35	10.4	309,874	8.86	7.9	852,369	7.72
Cold Protection	34.7	14,706	595.90	30.0	29,586	317.81	--	--	--	21.9	44,292	410.14
Hedging & Topping	1.8	190,920	2.39	2.7	196,294	4.25	0.4	80,567	1.46	1.7	467,781	3.00
Tree Removal and Replacement	5.1	242,530	5.30	5.4	264,570	6.40	7.5	309,874	6.40	6.0	816,974	6.07
Transportation	5.2	258,011	5.11	5.3	284,484	5.86	5.7	309,874	4.86	5.4	852,369	5.27

[1/] Acres include cross row as well as in row operation.

FLORIDA CITRUS PRODUCTION ENERGY USE 1977-78



UNIT: CITRUS PRODUCTION

MODULE: SITE PLANNING

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Identify five factors to consider when planning a grove site.	Cold Protection -topography -proximity to large bodies of water -latitude or how far south the grove is located in the Florida peninsular Soil Considerations -soil fertility -drainage -texture Access to Property -heavy equipment traffic on roads -distance to processing - hauling costs Land Value - interest on investment Taxes - related to land value Water -excess drainage -availability for irrigation Historical Performance -previous production -previous freeze damage	Read: Selecting a Grove Site, FC-22. Read Handout: "Vocabulary-Site Planning". Obtain copies of county land surveys. Divide class into groups and identify some potential grove sites for best production. Have each group identify five reasons why their selected site is a good location.

UNIT: CITRUS PRODUCTION

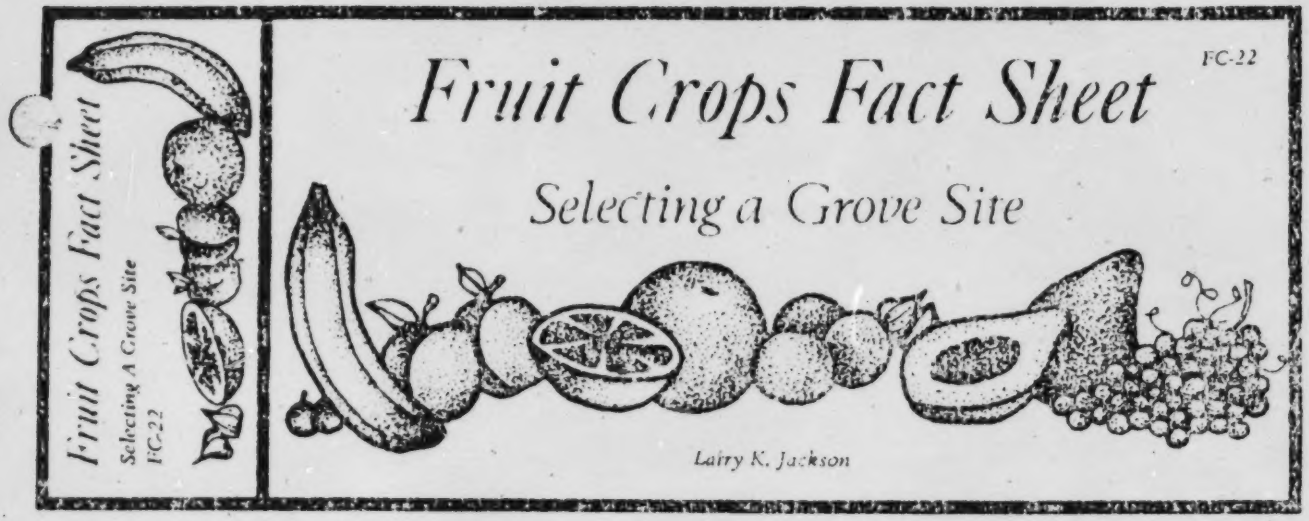
MODULE: SITE PLANNING

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
2. Given written descriptions of three different locations, evaluate the locations as possible grove sites.	Low area, near a lake, sandy soil, low taxes, easy access near highway to processing plant. Flatwoods, in south Florida, high valued land with high taxes, easy access to highway and processing plant. Good previous production performance, no access to property, moderate taxes and land value, no water nearby, planted on a hill, sandy loam soil.	Discuss each site location for possible grove planning. Rate each location as poor, good, or excellent. Read Handout: "Examples of Site Locations".
3. Identify eight ways to reduce potential energy requirements when selecting and planning a grove site.	Irrigation and Drainage (32.5%) -plant near a lake for irrigation, less cost than drilling a well -plant on sandy-loam soil on a hill, not on soils underlain with organic matter or hardpan Cold Protection (21.9%) -plant on hill, the warmer air rises, cooler air settles -plant near large bodies of water -do not plant in pockets Harvesting & Hauling (19%) -plant with good access to highway -plant near roads that can handle heavy equipment -plant near processing or packing plants to reduce hauling costs	Read: Citrus Energy Use and Conservation, EI-47. (See module on Energy Usage) Show transparency "Florida Citrus Production Energy Use 1977-78". (See module on Energy Usage) Evaluation: In essay form (50 word minimum) have student identify eight energy uses in Florida citrus production and explain how the energy requirements can be reduced when selecting a grove site.

UNIT: CITRUS PRODUCTION

MODULE: SITE PLANNING

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	Spraying and Dusting (7.2%) -plant near water for mixing acqueous solutions Tree Replacement (6.0%) Transportation (5.4%) -plant near accessible highway, processing or packing plant. Other (7.9%) -weed control -fertilizing -hedging, topping.	



Fruit Crops Fact Sheet

FC-22

Selecting a Grove Site

Larry K. Jackson

Florida Cooperative Extension Service / Institute of Food and Agricultural Sciences / University of Florida / John T. Woeste, Dean

This fact sheet updates and replaces Circular 185.

Selecting a site for establishment of the earliest Florida citrus groves consisted of selecting the most fertile location that was convenient to the grower's home. Little thought was given to cold protection until 1894-95 and again in 1898-99 when severe freezes forced growers to seek warmer sites.

Cold Protection Considerations

Three basic considerations, alone or in combination, determine how cold a grove site will be during a freeze when compared with other sites in the same general geographic area.

The first consideration is topography. Cold air is heavier than warm air and drains downhill, collecting in low areas that are often known as pockets. These low areas should be avoided to minimize the cold hazard. The site under consideration would have an adequate outlet provided by adjacent low areas into which cold air can drain.

The second consideration is proximity to large bodies of water. Freezes come into Florida from the north or northwesterly direction. Therefore, groves situated near lakes or large rivers will be afforded some protection by warming of the cold air by the water. Groves located near the Atlantic Ocean or Gulf of Mexico will also be afforded some degree of cold protection by proximity.

Low areas or pockets in the best and warmest citrus areas are often as cold or colder than areas north of the citrus area where it is not profitable to grow citrus. Moreover, citrus in cold pockets in warm areas is often more tender to cold than that grown farther north because the latter becomes more cold hardy by virtue of the generally cooler winter temperatures under which it is grown.

The third consideration is latitude or how far south the grove is located in the Florida peninsula. As a generalization, the farther south the grove is located, the less likely it is to be damaged during freeze conditions in Florida. Arctic air masses that bring freezing temperatures to Florida are moderated somewhat as they traverse the length of the state.

All previously mentioned variables are not present in all locations of the state, hence one cannot simply classify Florida into broad climatic zones based upon the anticipated or historical incidence of freezing temperatures. Each site must be appraised separately based upon all considerations.

Soil Considerations

As soon as the most desirable locations in central Florida were planted to citrus, growers began to move to the south and east to areas that were less fertile and were inherently poorly-drained. Serious freezes in 1957-58 and 1962 gave impetus to the southward movement of Florida citrus.

The areas that predominate in south Florida are basically characterized as poorly-drained or flatwoods soils. These are usually light sands underlain by an organic layer or hardpan that inhibits internal drainage. The water table in such soils is normally at or near the soil surface and must be lowered artificially to facilitate citrus growth.

Citrus in the flatwoods are usually planted on raised beds of soil that will accomodate 1 to 4 rows of trees (Fig. 1). Ditches separate the beds and facilitate water removal. The ditches carry excess water out of the grove into canals, and the water is then drained into larger canals, rivers, or other bodies of water. High beds and deep

Fig. 1. Typical "flatwoods" grove showing two-row beds and ditches.

Fig. 2. Typical "ridge" grove site showing rolling hills and lake.

ditches ensure best drainage and are most desirable for the growth of citrus, since this affords maximum rooting depth.

Soil types, drainage, texture, and the amount of organic matter in flatwoods soils can vary markedly even within a given area. The importance of a careful survey prior to planting cannot be overemphasized as this may help to prevent mistakes that the grower will have to contend with for the life of the grove.

Several soils other than flatwoods types are suitable for citrus. The area first planted to citrus, the rolling sandhills in central Florida, is largely well-drained (Fig. 2). These light sandy soils are usually underlain by a sandy clay layer. Clay or organic matter in the soil helps to retain moisture and nutrients for use by the trees.

Other soils may also be considered, but they are not as important due to the limited acreage available. The poorly-drained coastal areas underlain with shell, marl, or limestone are quite common in the Indian River area of Florida's east coast between Cocoa and Ft. Pierce. The oolitic limestone soils of extreme south Florida are predominately found in parts of Dade, Broward, and Monroe counties. Both soil types tend to be quite alkaline and may need special consideration in the cultural program.

Other Considerations

There are many other factors that govern the suitability of a grove site. Access to the property, land value, taxes, and water may be as important as soil or soil type. Access to the property is quite important, especially in selecting a grove site. Heavy equipment will need to be moved in and out of the grove periodically and roads will need to be in good condition to accommodate this traffic. Distance from a processing or packing facility should also be considered as hauling costs may increase with distance.

Land value and taxes go together. Some land is simply too valuable to grow citrus on and should not be considered. Unfortunately, much good grove land is also desirable real estate, especially if the area is near a population center. Land purchased at a high price is also likely to carry high property taxes. Property tax may vary from area to area and should be thoroughly checked out. Special exemptions for agriculture may not always be in effect.

Water has always been a problem and will probably be the cause of even more problems in the future. Excess water in poorly-drained areas must be dealt with. Removal of water from the grove is only part of the problem. What to do with the water next is often a problem of even greater significance and must not be ignored.

Availability of water for irrigation is quite important. The demand for water is also increasing as the population of Florida grows. Citrus trees will no doubt have a lower priority than people if water shortages develop. Therefore, sites should be selected when possible that will do reasonably well without supplemental irrigation.

There are no hard and fast rules that delineate good or poor grove sites. Some of the most important considerations are listed in this publication. Historical performance of the site and others nearby should also be taken into account.

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF FLORIDA, INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES, K. R. Tefertiller, director, in cooperation with the United States Department of Agriculture, publishes this information to further the purpose of the May 8 and June 30, 1914 Acts of Congress; and is authorized to provide research, educational information and other services only to individuals and institutions that function without regard to race, color, sex or national origin. Single copies of Extension publications (excluding 4-H and Youth publications) are available free to Florida residents from County Extension Offices. Information on bulk rates or copies for out-of-state purchasers is available from C. M. Hinton, Publications Distribution Center, IFAS Building 664, University of Florida, Gainesville, Florida 32611. Before publicizing this publication, editors should contact this address to determine availability.

HANDOUT

VOCABULARY - SITE PLANNING

1. Topography - the physical characteristics of a place or region.

2. "Pockets" - low areas of land, usually collect cold air.

3. Proximity - nearness or closeness.

4. Latitude - the angular distance north or south of the equator.

5. Flatwoods - poorly drained South Florida soils, usually sands underlain with organic matter or hardpan.

6. Texture - structure or composition of a soil.

7. Access - the right to enter or use.

8. Delineate - describe or outline accurately.

9. Historical Performance - previous production or freeze damage on same location.

HANDOUT

EXAMPLES OF SITE LOCATIONS

Evaluate each example of site locations for possible planting of a grove site in Florida.

Identify each characteristic as being poor-good-or-excellent. Then give the overall site the same rating.

Example #1: You are looking at 50 acres of land near Orlando in Lake County. There is some slope to the land toward a lake located in a lower area of this tract. The soil is very fine sand. According to the County Tax Appraiser, taxes on this land out in the county-rural area are to remain low and will always be zoned agricultural. There is a set of crossroads near the north end of the 50 acres. The care of the roads is the county's responsibility.

Example #2: You have an option to buy 25 acres of land near Miami. There exists an organic matter layer underneath the top soil. The land in this area is reaching a maximum value at this time. But the taxes even on undeveloped land are high. There exists a multi-network of roads around this area.

Example #3: You have been made aware of a 50 acre grove for sale. When talking to the owner you found the historical performance to be average to above average. This grove is located on a hill behind other groves. The land value and taxes here are moderate. That makes this grove affordable to your company. The soil has been typed as sandy loam. Without a lake near by fishing may become a problem.

ANSWERS

TO

EXAMPLE OF SITE LOCATIONS

Example #1.
low area - poor
near a lake - good
sandy soil - good
low taxes - excellent
easy access to highway - excellent

OVERALL: EXCELLENT

Example #2
flatwoods - poor
south Florida location - good
high valued land - poor
high taxes - poor
easy access to highway - excellent

OVERALL: POOR

Example #3
historical performance - good
access to property - (none) - poor
moderate taxes - good
moderate land value - good
water - (none) - poor
planting location (hill) - good
sandy loam soil - good

OVERALL: GOOD

UNIT: CITRUS PRODUCTION

MODULE: PLANTING OF SEEDLINGS

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify four factors influencing the need of higher density planting of Florida citrus.	Factors influencing need of higher density plantings -shortage of suitable land -energy costs -restriction on water -fixed costs -harvesting problems	Read Handout: "Planting of Florida Citrus Groves".
2. Identify average row spacings for Florida citrus.	25 X 25 ft (7.62 X 7.62 m) for oranges 25 X 30 ft (7.62 X 9.14 m) for grapefruit	Field trip: Visit area groves and measure the between-row and in-row spacings. Try to find groves with different dimensions.
3. Identify two findings of the tree-spacing trial conducted at the Lake Alfred, AREC, Davenport Grove.	Findings -increased production per acre -the closest two spacings recovered planting cost and annual cultural practices cost more quickly than widest block	
4. Identify two disadvantages of high density plantings for Florida citrus.	Disadvantages -tractor and equipment size -tree size	Evaluation: Individual is to develop a project on citrus planting. Student should design a layout for a grove. Accompanying the design should be a report explaining the reasons for the spacing, what the student expects production to be, and what basic problems will be encountered in grove management.

HANDOUT

PLANTING OF FLORIDA CITRUS GROVES

Energy is used in nearly every citrus grove management technique. One major topic has been the subject of higher density planting. This has to do with the spacing of citrus trees closer together to achieve higher acre efficiency or producing the greatest amount of citrus per acre at the most reasonable cost.

Some factors influencing the need for improving acre efficiency are:

1. Shortage of suitable land - Most of Florida's good citrus growing land has already been planted. At the same time many citrus groves are being destroyed for urban development; shopping centers, houses, roads, etc.

2. Energy cost. - It is wasteful for a powerful sprayer to be pulled by a powerful tractor up and down widely spaced rows of citrus trees. Spacing trees to minimize the use of fuel and other energy in citrus production would result in a larger profit.

3. Restriction on water - Recently state and local laws have restricted the use of water in some areas of our state. Closer plantings would use water more efficiently but may require more water per acre.

A tree spacing trial was initiated in 1962 at the Lake Alfred, AREC, Davenport grove. "Pinapple" orange trees on rough lemon rootstock were planted in an experiment which included 3 spacings: 10 X 15 ft, 15 X 20 ft and 20 X 25 ft. Cultural practices were identical in the three spacings with the following exceptions: 1. Fertilizer rates were higher in the closer spacings. 2. Trees in the 15 X 20 ft spacings were pruned during the 1976-77 season, trees on the 10 X 15 ft spacing were pruned annually since 1975; and every fifth tree in the rows were removed during 1976-77 season for ease of picking.

With the 20 X 25 ft spacing, the average yield for the 8 through 10 year-age period was 346 boxes per acre and that for the 14 through 16 year-old age period was 576 boxes per acre.

The 15 X 20 ft spacing for the same period yielded 489 boxes per acre and 730 boxes per acre.

In the closest tree spacing, 10 X 15 ft, average yields were 614 boxes per acre and 822 boxes per acre.

Planting costs were higher in the close-spaced blocks. However, the results through 13 years (measuring the net income) show that the closest spacing recovered planting cost and annual cultural practices cost more quickly than the wider spaced plantings.

There are some definite disadvantages for planting citrus grove at higher density spacings. 1. The crowding of closely planted trees will make average grove equipment impassable between the closer rows. Farm machinery technicians are currently working to develop new tractors and equipment that will work with the narrower spacings. 2. Tree size can be a problem. Scientist are developing methods of controlling tree size with viruses and different rootstocks. 3. Pruning and hedging practices will also have to be changed to meet the requirements of different varieties and spacings.

The information gathered from experimental and commercial higher density plantings in Florida indicate spacings of 10 X 15 ft, 15 X 20 ft or 20 X 25 ft should be considered for oranges. These decisions will depend upon the vigor of the scion/rootstock combination, soil fertility, climatic conditions and the expected life of the planting.

LOW ENERGY TECHNOLOGY

UNIT: CITRUS PRODUCTION

MODULE: GROVE OPERATIONS

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify three areas that affect the performance of a tractor.	Operation - What is the tractor doing? Ballast - Weighting the tractor Tune-up	Read Handout: "Field Operations".
2. Identify three factors influencing tractor fuel consumption.	Load Engine speed Gear used Engine idle	Student Activity - Obtain a tractor and inspect it for proper load, engine speed, gear used and engine idle. Compare your results to Nebraska Tests.
3. Identify two effects that happen directly because of a tractor tune-up.	Reduced fuel consumption Increase the amount of work that can be done	
4. Identify five tune-up operations that should be done according to the owner's manual.	Ignition timing Spark plugs Air cleaner Carburetor adjustments Govenor adjustments	Have students call local parts dealers and get estimates on the cost of a tune-up. If a shop is available, have a mechanic perform these energy saving techniques.

UNIT: CITRUS PRODUCTION

MODULE: GROVE OPERATIONS

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
5. Identify two prominent methods of weed and grass control for energy savings.	Mowing - chopping Discing Herbicides	Read Handout: "Weed Control".
6. Identify two energy saving tips to consider when pruning citrus.	Consider maintenance pruning Consider angles when hedging or topping	Read Handout: "Pruning - Hedging".
7. Identify four fuel-saving tips which begin before you start your engine.	Check tank, lines, fuel pump and carburetor for leaks Don't let tank stand empty Check usage against bill Don't overfill tank Maintain records by vehicle and use	Read Handout: "Gasoline and Engine Saving Tips". Evaluation: See Grove Operations Exam.
8. Identify five operating tips to save energy.	Avoid excessive warm-ups Hold idling to a minimum and avoid high speed Don't leave the choke out Let clutch out slowly Run tractor in proper gas for load and condition	

UNIT: CITRUS PRODUCTION

MODULE: GROVE OPERATIONS

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	Be sure thermostat is working properly	
9. Identify four check tips for maintaining engines and saving energy.	Spark plugs Fuel mixture Regularly scheduled tune-ups Properly inflated tires Improper lubrication Loose fan belt Low oil levels	

30

HANDOUT

FIELD OPERATIONS

In 1974, Florida growers consumed over 200 million gallons of gasoline and diesel fuel in farming operations. Most of this fuel was used in trucks and tractors. As the amount of the grower's dollar spent for energy has increased, the maintenance of equipment for maximum efficiency in operation and fuel consumption has become increasingly important.

During each growing year, field equipment is needed to perform a number of tasks in a short span of time. Each task and the equipment associated with it affect the fuel performance of a tractor. Well-maintained equipment use less energy and reduces the amount of time needed for each task -- again saving money for the grower.

TRACTOR OPERATION

In general, there are three areas that affect the performance of a tractor in the field; the operation, ballast (weights) and tune-up.

The amount of tractor fuel required to perform a specific amount of work depends largely on how the tractor is operated. The load, engine speed, gear used and amount of engine idle can cause fuel consumption to vary considerably.

For most jobs, a tractor is loaded to about 50 percent of its capacity. This practice reduces maximum fuel efficiency. Reducing engine rpm while performing light work will improve the fuel efficiency, according to several studies conducted by the University of Nebraska. Because diesel engines run more efficiently at a 50 percent load and reduced rpm than at their rated capacity, a grower can use a larger diesel tractor for a small job and get better performance than a smaller diesel tractor working at its rated load capacity.

Many operators allow tractors and other equipment to stand and idle for long periods of time. Since an idling engine can use a half a gallon of fuel per hour, it should be shut off when not in use.

BALLAST

Adding ballast to the front of a tractor increases stability or steering responsiveness. Ballast is added to the rear of a tractor for increased traction which conserves fuel and reduces wear-and-tear on the tractor. Improper weighting of tractors causes fuel waste and excessive slippage. One method to check for proper ballast is to observe the tire tread marks. When the weight on the tires is too light, tread marks will be wiped out due to wheel slippage. When there is too much weight, tire tracks will be sharp in the soil. When tires are weighted properly, the soil between the cleats in the tread marks is shifted, but the tread pattern is still visible.

TRACTOR TUNE-UP

The effectiveness of regular tune-ups of farm equipment can best be demonstrated by the results of a research project conducted at Kansas State University. In this study, 50 tractors were randomly selected, tested and then given a tune up. As a result, their fuel consumption was reduced by 14.5 percent and the horsepower of the 50 tractors was increased by 11 percent. This means that in addition to reducing fuel consumption, the tune-ups increased the amount of work that could be done by 11 percent.

Tune-up operations that should be performed according to the owner's manual include ignition timing, spark plugs, air-cleaner, carburetor adjustments and governor adjustments. Growers who do their own tune-ups should periodically have their equipment checked by a dealer to compare it with the originally rated performance. If the engine is performing far below its rated performance after a tune-up additional work may be needed on the tractor to improve its efficiency.

HANDOUT

WEED CONTROL

The mechanical and chemical (excluding the herbicide material) methods of weed control requires an estimated 3.4 percent of the energy consumed in a citrus operation.

Because of the shallow root depths caused by the high water tables in the Indian River-Flatwood areas, less disking and chopping is practical there than in the Ridge areas of the state. The fuel consumption per acre does not differ much for these operations.

Weed control is one of the operations consuming a relatively small portion of the total energy required for citrus production. However, any reduction in the numbers of treatments or the use of a less energy intensive process will conserve energy.

The use of herbicides is considered to be less intensive than the mechanical weed control procedures. At present chemical weed control is more common in the Indian River-Flatwood of the state. It is anticipated that chemical weed control will become more common part of the citrus production program in all areas of the state and will save labor, reduce equipment use, reduce energy requirements and increase profits.

HANDOUT

PRUNING - HEDGING

Pruning is one of the most energy-intensive production practices used but one that can pay off handsomely in yield, in quality improvement and in more efficient equipment operation. Approximately 1.7 percent of the energy used in citrus groves is for pruning - hedging. A few tips to consider are:

1. Consider maintenance pruning - Heavy pruning results in loss of production, increased costs, and troublesome brush disposal. This points to the importance of a regular maintenance program.

2. Make best use of angles and heights - A variety of angles and heights for hedged and topped citrus trees are available. No one recommendation is best for all situations. Plan carefully when considering angles and heights to maximize sunlight interception and minimize next year's pruning job. There is some loss of fruit the year following hedging, but over a period of years the yields will be as great and fruit quality will be improved.

Hedging and topping operations often remove limbs too large to be cut by a mower and these have to be removed from the groves. This requires the use of power equipment such as a payloader and bulldozer to remove the severed material. The size of this operation varies considerably but it is estimated five gallons of fuel per acre will be required.

Much of the brush from the hedging and topping operations in those groves with an established program can be disposed of by mowing or disking.

HANDOUT

GASOLINE AND DIESEL ENGINES SAVING TIPS

Gasoline and diesel powered engines used in crop production are the biggest on-farm users of energy. You can have a direct impact on reducing total energy use by conserving fuel.

Fuel-saving begins before you start an engine. The following tips may save you fuel, dollars, and problems:

1. Check tank, lines, fuel pump, and carburetor for leaks.
2. Don't let the tank stand empty, especially in cold weather, condensation may form.
3. Check your usage against your bill.
4. Don't overfill; leave room for expansion.
5. Maintain dispensing records by vehicle and by task performed. This can identify high and wasteful usage.

ENGINE OPERATING TIPS

The way a vehicle is operated can save fuel without changing the amount of work or the way the work is done. Here are some fuel-saving ideas:

1. Avoid excessive warmups in cold weather.
2. Idling can consume 15 to 20 percent of the fuel used. Hold it to a minimum, and avoid excess idle speed.
3. Don't leave the choke out.
4. Let out the clutch slowly; quick starts waste fuel and are hard on equipment.
5. Run tractors in the proper gear for the load and condition. Improper shifting and use of the wrong gear can result in a 5 percent fuel loss.
6. Be sure the thermostat is working properly.

MAINTAINING GAS AND DIESEL ENGINES

You are well aware of the importance of good maintenance of equipment. The following energy-saving maintenance tips may be helpful reminders:

1. One fouled spark plug or one stuck valve lifter can cause a loss of 10-15 percent of the fuel used in a vehicle
2. Too rich a mixture wastes fuel because it prompts excessive choke use.
3. Too lean a mixture wastes fuel because it prompts excessive choke use.
4. Regularly scheduled tune-ups can save up to 10 percent on fuel usage.
5. Keeping the tires of your tractor and other implements properly inflated saves energy.
6. Improper lubrication, loose fan belt, or low oil level will increase fuel consumption.

LOW ENERGY TECHNOLOGY CITRUS PRODUCTION

GROVE Operations Exam

1. List three areas that affect the performance of a tractor.

   a.

   b.

   c.

2. Identify three areas influencing tractor fuel consumption.

   a.

   b.

   c.

3. Identify two effects of tractor tune-up.

   a.

   b.

4. Identify tune-up operations that should be done according to the owner's manual.

   a.

   b.

   c.

   d.

   e.

5. Identify two methods of weed and grass control for energy savings.

   a.

   b.

6. Identify two energy savings tips to consider when pruning citrus.

   a.

   b.

7. Identify four fuel saving tips to perform before starting your engine.

   a.

   b.

   c.

   d.

8. Identify five operating tips to save energy.

   a.

   b.

   c.

   d.

9. Identify four check tips for maintaining engines and saving energy.

   a.

   b.

   c.

   d.

UNIT: CITRUS PRODUCTION

MODULE: INTEGRATED PEST MANAGEMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify five types of spraying and dusting operations used in citrus production and the type of fuel and average amount used per acre for each operation.	Spraying and Dusting Operations -Auxiliary Engine Air Spraying (56.7%) -25 gallons of diesel/acre of treatment -P.T.O. Air Spraying (17.9%) -1.75 gallons of diesel/acre of treatment -Fixed Wing Aerial Spray (15.1%) -0.5 gallons of gas/acre of treatment -Rotary Wing Aerial Sprayer (1.7%) -0.68 gallons of gas/acre of treatment -Tractor Dusting (1.2%) -0.40 gallons of diesel/acre of treatment -Truck Dusting (1.6%) -0.40 gallons of diesel/acre of treatment -Aerial Dusting Fixed Wing (5.8%) -0.51 gallons of gas/acre of treatment	Read: Citrus Energy Use and Conservation, EI-47. (See module on Energy Usage.) Show transparency: "Spraying and Dusting - 7.2% 1977-78" Show transparency: "Spraying and Dusting. Read Handout: "Spraying and Dusting". Discuss the energy cost/acre assuming average cost of a gallon of gas = $1.30 and a gallon of diesel = $1.25. Collect pictures of different types Evaluation: Student must complete the test on spraying and dusting with 70% accuracy.
2. Identify five factors to consider when planning a dilute pesticide application by spray machine.	Dilute Pesticide Application -thorough coverage is required -both inside and outside foliage -trunk and limbs (wood) -all currently recommended miticides and scalicides except sulfur kill only upon contact with pest.	Read: Florida Citrus Spray Guide 1981, or more recent copy. Resource Person: Have a grove manager discuss identifying pests, pesticides and cost of dilute applications with class.

UNIT: CITRUS PRODUCTION

MODULE: INTEGRATED PEST MANAGEMENT

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	-poor coverage means poor control and costly failure. -spray distribution requirements -pests to be controlled -speciality varieties -tree spacing -pruning	Evaluation: Student must identify five factors to consider when planning a dilute pesticide application in essay form. (50 word minimum)
3. Identify when to use concentrate spray and seven factors contributing to a successful concentrate spray program.	Factors contributing to a successful concentrate spray program -the use of only well-trained, competent spray operators -do not spray when the wind is above 5 mph -nozzling sprayer to put two-thirds of material in the upper one-half of the tree -reducing spray materials by 25% of 3 times (1/4 dilute gallonage) or higher concentrations to avoid higher residue -do not exceed a ground speed of 1 m.p.h. -use a concentrated oil spray only upon recommendation of the sprayer manufacturer	Read "Florida Citrus Spray Guide 1981", or more recent issue. Resource Person: Citrus caretaker should discuss identifying pests, pesticides and costs of concentrate pesticide applications. Evaluation: Student must identify when to use a concentrate spray and seven factors contributing to a successful concentrate spray program in essay form (50 word minimum).
4. Identify six factors to consider when planning an aerial application of pesticides.	Aerial application of pesticide -target population -citrus rust mite -aphids -suppression of black scale	Read: Florida Citrus Spray Guide 1981, Pesticide Application. Resource Person: Have an area grove spraying pilot discuss his training and responsibilities.

UNIT: CITRUS PRODUCTION

MODULE: INTEGRATED PEST MANAGEMENT

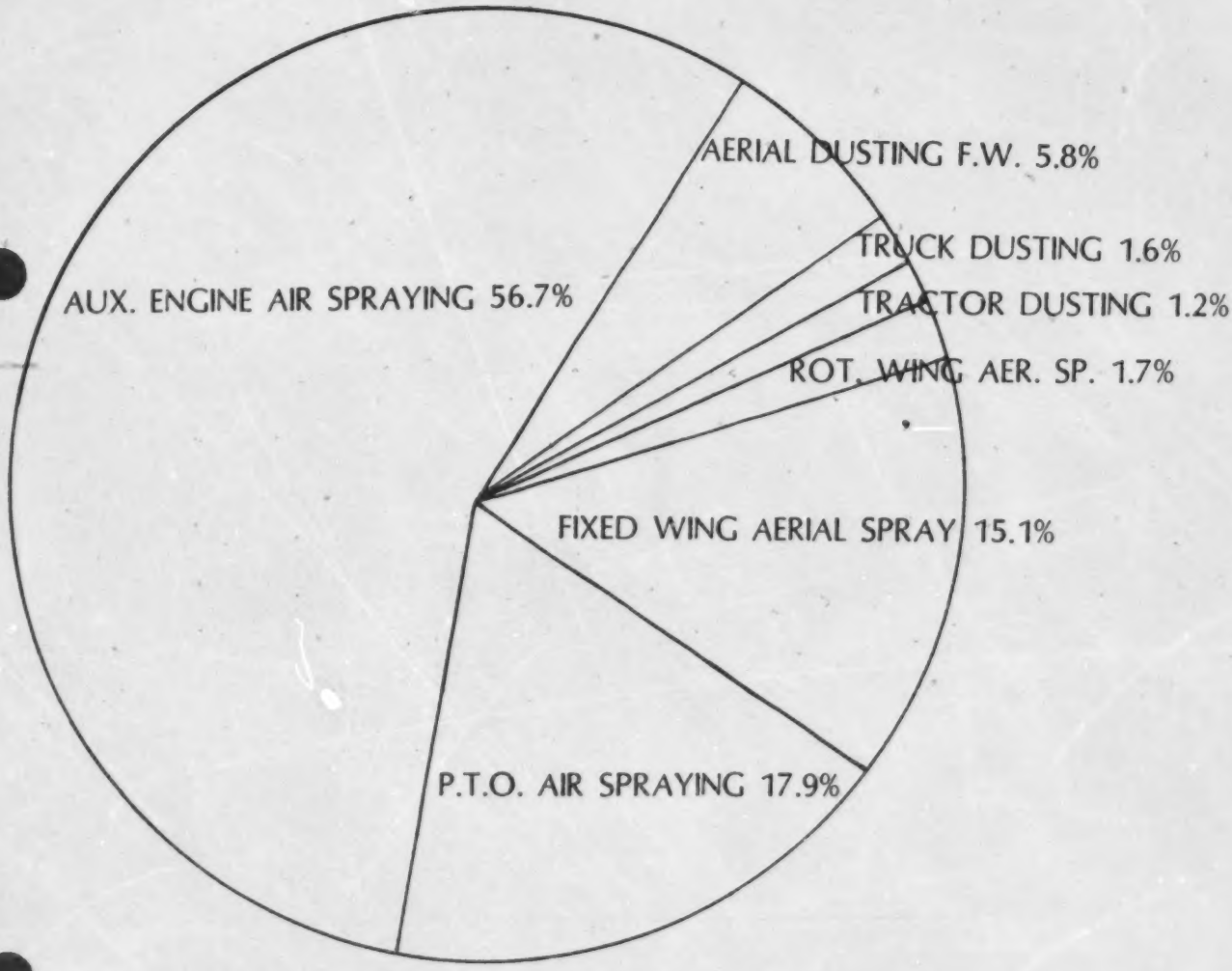
STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	-rates of materials per acre -materials should be mixed with sufficient water -do not spray when wind is above 5 mph. -spray only one row of trees per pass. -helipcopter ground speeds should be 20-25 mph. -fixed wing aircraft should be operated at manufacturer's specifications -do not apply by air where it is prohibited -three control methods of IPM	Evaluation: Student must identify six factors to consider when planning an aerial application of pesticide in essay form. (50 word minimum)
5. Identify three control methods of Integrated Pest Management and two desirable affects of each control method.	-biological -fungus attacking whiteflies -fungus attacking rust mite -fungus attacking milkweed vine -Aphytis wasps parasitic on scale -another parasitic wasp controls citrus white fly -chemical -initial kill of the target organism -effects target pest flare-ups -secondary pest outbreaks	Read Handout: "Integrated Pest Management in Florida." Conduct experiments with each type of control methods of I.P.M. with the students divided into groups. Student must identify three control methods of I.P.M. and two desirable affects of each control method.

UNIT: CITRUS PRODUCTION

MODULE: INTEGRATED PEST MANAGEMENT

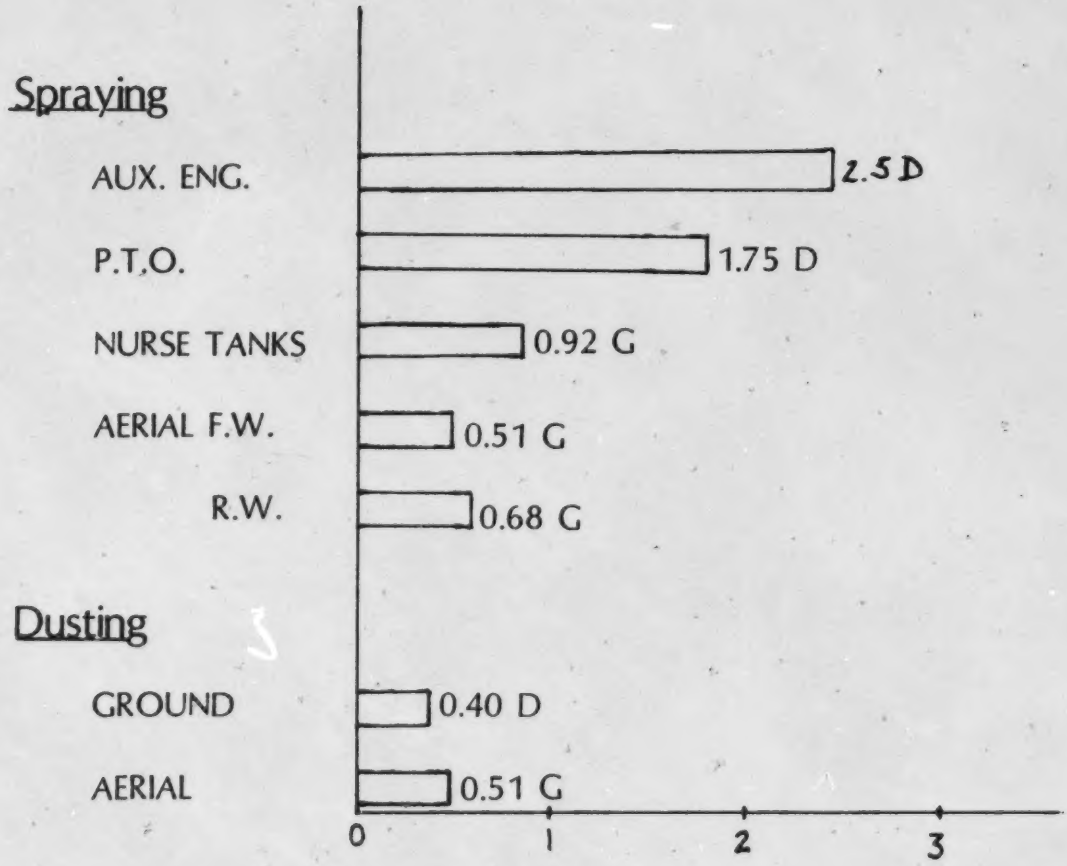
STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	-possible adverse effects on grove workers and environment -some adverse effects -cultural -cover crops -timing of cultivation and mowing operations -effective control of weeds has eliminated plant competition and results in more vigorous tree growth, increased air movement and improved operating conditions -coexistence	
6. Identify three ways IPM can reduce energy.	Ways IPM reduces energy -reduces required amount of pesticide -reduces number of applications -better pest management and pesticides are applied on a symtomatic basis rather than a pre-scheduled basis. -reduce required amount and number of applications by application only when symptom warrant.	Student discussion or debate topic.

SPRAYING & DUSTING - 7.2% 1977-78


AERIAL DUSTING F.W. 5.8%
TRUCK DUSTING 1.6%
TRACTOR DUSTING 1.2%
ROT. WING AER. SP. 1.7%
FIXED WING AERIAL SPRAY 15.1%
P.T.O. AIR SPRAYING 17.9%
AUX. ENGINE AIR SPRAYING 56.7%

42

SPRAYING & DUSTING



Fuel per acre treatment (Gal.)

G-GASOLINE

D-DIESEL

HANDOUT

SPRAYING & DUSTING

_____ 1. Axillary Engine Air Spraying (56.7%)

_____ 2. Truck Dusting (1.6%)

_____ 3. Aerial Dusting Fixed Wing (5.8%)

_____ 4. Tractor Dusting (1.2%)

_____ 5. Rotary Wing Aerial Sprayer (1.7%)

_____ 6. Fixed Wing Aerial Spray (15.1%)

_____ 7. P.T.O. Air Spraying (17.9%)

A. 1.75 gallons of diesel/acre

B. 0.40 gallons of diesel/acre

C. 0.51 gallons of gas/acre

D. 0.68 gallons of gas/acre

E. 0.40 gallons of diesel/acre

F. 2.5 gallons of diesel/acre

G. 0.51 gallons of gas/acre

HANDOUT

INTEGRATED PEST MANAGEMENT IN FLORIDA[1]

Florida's warm, humid weather is conducive not only to citrus production but to tremendous pest pressure exerted by a wide range of plant diseases, insects, mites, nematodes, and weeds. This same climate also favors a wide range of natural enemies of these pests. Nowhere else in the world have natural enemies been employed to such an extent to combat the wide range of potential plant pests as on Florida citrus.

CONTROL METHODS

As the citrus industry evolved during the past century, so has the development of biological, chemical, and cultural pest control programs.

Biological: The first recognized biological control agent was a fungus attacking whiteflies published in 1897. Since then several natural occurring fungus diseases, parasites, and predators have been described. A natural occurring fungus attacking the rust mite, Hirsutella thompsonii Fisher, and one attacking the milkweed vine, Phytophthors citrophthora (Sm. and Sm.) Leioian, are being evaluated for commercial production, both having a temporary tolerance. The introduction of two Aphytis wasps parasitic on scale, in conjunction with an endemic species, Aphytus lingnanensis Compere, specific for the citrus snow scale, is being reared at the Lake Alfred Agricultural Research and Education Center for release in pockets of heavy infestations.

The citrus blackfly, Aleurocanthus woglumi Ashby, was discovered in the Ft. Lauderdale area in 1976. Since then, this pest has been detected in several other citrus producing counties of Florida. In 1979, a chemical eradication program was discontinued with the pest being held at subeconomic levels by two introduced parasites, Amitus hesperidum Silvestri and Prospaltells opulenta Silvestri.

Another parasitic wasp. Prosphaltella lahorensis (How.), was recently introduced to control the citrus whitefly, Dialeurodes citri (Ashm.).

Chemical: Chemical recommendations were published in 1936 for the control of citrus pests and have been revised annually. This method of control continues to play a viable role in our IPM program. Research personnel evaluate chemical control agents not only for the initial kill of the target organism, but for effects on target pest flare-ups, secondary pest outbreaks, and possible adverse effects on grove workers and the environment. They have refused to recommend or withdraw recommendation from chemicals that have proved to create more problems than they solve. Certain fungicides used for the control of greasy spot and other phytopathogenic fungi of citrus will also kill fungi that attack insects of mites; i.e., Hirsutella and Aschersonia. Many times, upsets caused by these fungicides may increase pest populations, such as citrus rust mites and whiteflies.

fungicides used for the control of greasy spot and other phytopathogenic fungi of citrus will also kill fungi that attack insects of mites; i.e., Hirsutella and Aschersonia. Many times, upsets caused by these fungicides may increase pest populations, such as citrus rust mites and whiteflies.

Thompson (1939) showed that heavy inert residues of copper and zinc compounds not only inhibited growth of entomogenous fungi which attached mite and scale insects, but created conditions favorable for increase in purple and Florida red scale populations. These conditions appeared to overshadow any appreciable effect the fungi may have had.

Cultural: Muma (1961) showed that cover crops have desirable effects on arthropod populations in citrus groves. Loss of cover crops reduces the food and habitat for general predators and other natural enemies. Timing of cultivation and mowing operations can influence the occurrence and severity of fruit infestation by certain insects such as grasshoppers, stinkbugs, and leaf-footed plant bugs. Insects are known to favor specific weeds, which when destroyed, will result in the relocation of adults into the tree canopy. However, effective control of weeds by mechanical methods, chemicals, hand removal, and/or biological control, has eliminated plant competition and resulted in more vigorous tree growth, increased air movement, and improved operating conditions.

The burrowing nematode, Radopholus similis (Cobb), is the cause of spreading decline, once considered to be one of the most serious diseases affecting Florida citrus. Present concerns for the environment and for grove workers when chemical control is used have made coexistence with this pest almost mandatory. O'Bannon and Tarjan (1978) outline how supplemental irrigation, accompanied by regular sound grove management practices, will maintain productivity in infested groves.

SUMMARY

Citrus IPM is a complex program in that citrus is a perennial tree crop consisting of several varieties with staggered maturity dates, produced for 2 markets, grown under different conditions. An effective IPM program must remain dynamic, flexible, and continuous due to the complexity of the industry, pressure from existing pests, introduction of new pests, and the loss of effective pesticides through the regulatory process and resistance.

REFERENCES CITED

Muma, M. H. 1961. The influence of cover crop cultivation on populations of injurious insects and mites in Florida citrus groves. Fla.

O'Bannon, J. H. and A. C. Tarjan. 1978. Effective pest management of the burrowing nematode on citrus. Citrus Inc. 6:18:23.

Thompson, W. L. 1939. Cultural practices and their influence upon citrus pests. J. Econ. Entomol. 32:782-9.

[1] J. L. Knapp, INTEGRATED PEST MANAGEMENT IN FLORIDA CITRUS
Agricultural Research and Education Center, Cooperative Extension Service. University of Florida, 700 Experiment Station Rd., Lake Alfred, FL. 33850

LOW ENERGY TECHNOLOGY CITRUS PRODUCTION

IPM Exam

1. Fill in the following table.

	Type of Spraying	Type of Fuel	Avg. Amount/Acre
A.			25 gallons
B.	PTO Spraying		
C.		gasoline	
D.	Rotary Wing Aerial		
E.			0.51 gallons

2. What type of dusting uses 0.51 gallons of gasoline per acre? _____

3. Identify five factors to consider when planning a dilute perticide application.

   a.

   b.

   c.

   d.

   e.

4. Identify seven factors contributing to a successful concentrate spray program.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

5. Identify six factors to consider when planning an aerial application of pesticides.

   a.

   b.

   c.

   d.

   e.

   f.

6. Identify three control methods of IPM and two disirable affects of each control method.

   a.
      1.
      2.

   b.
      1.
      2.

   c.
      1.
      2.

7. Identify three ways in which IPM can reduce energy usuage.

   a.

   b.

   c.

LOW ENERGY TECHNOLOGY

UNIT: CITRUS PRODUCTION

CITRUS PRODUCTION

MODULE: FERTILIZATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify the current fertilization rates of Nitrogen (N) and Potassium (K_2O) per box of fruit produced per year and the maximum amount per acre on Florida citrus grove soils.	Fertilization rate and amount -0.3-0.4 pound of N and K_2O per box of fruit produced per year -per acre maximums of 150-250 pounds of N and K_2O are now the rule	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Have students weigh 0.3-0.4 pounds of N and K_2O fertilizer on a scale and compare this amount to a box of picked oranges. Have students mark off an acre of land and compare this area to 150-250 pounds of fertilizer.
2. Identify two advantages of the new rate applications of fertilizer.	Two advantages of rate applications -Rates save energy and money. By using less quantity of fertilizer, you would save money in purchasing the product. Thus, production and application energy would also be reduced by conservation. -These new rates have usually netted growers larger returns.	Read: Energy Saving Tips for Growing Florida Citrus, FC-48.
3. Identify two advantages and one disadvantage of high analysis fertilizers.	High analysis fertilizers -cheaper per unit of plant food -costs less to haul and spread due to smaller volume required -the use of straight materials and liquid or liquid-dry application systems require special equipment	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Visit a fertilizer plant and have the students examine fertilizers with various analyses. Have students apply some high analysis fertilizer to a grove or garden plot

UNIT: CITRUS PRODUCTION

MODULE: FERTILIZATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
4. Identify one advantage and one disadvantage of adjusting application frequency.	Application frequency -most citrus groves are now on a twice-a-year application schedule -considerably more efficient than the old system of 3 or 4 applications per year -the use of slow-release materials may reduce application frequency even more -slow-release materials are not yet recommended, more information is needed on these materials	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Set up a demonstration of slow vs. fast Have students plan a fertilizer application schedule for their own "imaginary" grove.
5. Identify two advantages of soil and leaf analysis for saving energy in Florida's citrus production.	Soil and leaf analysis -adjustments can be made before deficiencies actually occur -wasteful excesses can be trimmed off before they can cause potential harm	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Have students choose two transplant seedlings to experiment. Students must identify the nutrients needed for optimum growth of that particular seedling. Then students should choose one element for each seedling to reach a level of toxicity for one seedling and a level of deficiency for the other. A toxicity or deficiency should be chosen with recognizable leaf symptoms. Have students test the soil and leaves for fertilizer need analysis or send the samples to the Extension Service.

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
6. Identify the optimum level of pH in the soil for growing citrus.	Citrus grows best at a pH level of between 6.0-7.0.	Read: Energy Saving Tips for Growing Florida Citrus, FC-48.
7. Identify three disadvantages of not maintaining the optimum pH level of 6.0-7.0 for growing citrus.	Disadvantages of other pH levels -poor tree growth -poor yield -inefficient utilization of applied fertilizer materials	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Have students raise or lower the pH level in a potted seedling. Evaluation should be in the form of a lab report including how they changed the pH and the results.
8. Identify two benefits from using Hairy Indigo as a cover crop.	Hairy Indigo -increase organic matter in the soil -increase the level of nitrogen in the soil	Read: Hairy Indigo as a Cover Crop in Florida Citrus, Circular 227.

LOW ENERGY TECHNOLOGY
CITRUS PRODUCTION

UNIT: CITRUS PRODUCTION

MODULE: IRRIGATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Identify four types of irrigation available to the citrus producer and their respective efficiency.	High pressure guns - large energy users - versatile - 80% efficiency Permanent Overhead Sprinklers - medium range energy users - can be used for frost protection - 75% efficiency Drip and low volume - conserve energy and water - clogging can become a problem - 85% efficiency Seepage - low energy requirements - soil limitations - 50% efficiency	Read: Citrus Irrigation Management, Circular-444, pp. 12-19. Take a field trip to surrounding groves to see different types of irrigation. Upon completion of field trip, have each student sketch and identify all the types of irrigation that were demonstrated.
2. Identify six factors influencing energy loss due to the type of irrigating system.	Energy loss due to types of irrigation System. - increasing efficiency of irrigation equipment can conserve energy and reduce the costs of pumping water	Read and discuss Handout: "Energy Loss Due to Type of Irrigating Systems". Visit area groves and evaluate the energy efficiency and use of their equipment.

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	- uniform valves for time of irrigation, higher valves for night. - spacing of sprinklers - evaporation loss is higher during the day - evaporation loss from volume gun are less than half that of the permanent overhead - efficiency is reduced on overhead sprinklers when operated in recently planted widely spaced groves - applications in excess of tree needs decreases over efficiency - applications in excess of water holding capacity also decreases overall efficiency - when low volume is run continuously for a long period of time water movement beyond the root zone may result	
3. Determine soil moisture content by using gravimetric tensiometric and neutron scattering methods.	Gravimetric Method - least technical - most laborious Tensiometric Method - soil moisture tensiometer - not totally reliable - variability in Florida soil Neutron Scattering Method - instrument needed: fast neutron source, a slow neutron detector, and a counting device.	Read: Citrus Irrigation Management, pp. 5-6. Have a resource person (i.e., County Extension Agent, Soil Conservation Service Officer) demonstrate the the use of all three methods. Divide class up into small groups. Borrow equipment to provide each student group with the experience of operating and calculating each method.

UNIT: CITRUS PRODUCTION

MODULE: IRRIGATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
4. Use the Accounting Method to determine the need for irrigation.	Water Account System - ordinary bank account -rainfall and irrigation -daily use - evaporation and transpiration - mean temperature - average daily moisture requirements	Read Handout: "The Accounting Method." Calculate Irrigation frequency (in days) according to the usuable soil moisture (in.) and high daily ET (in.) for your area.
5. Identify five factors influencing the selection of an irrigation system.	Tree survival vs increased yields Availability of water - water quality - water source - crucial water shortages occur seasonally in areas of Florida - consumptive usage regulations Energy requirements of system - increasing cost of fuel and electricity Fixed or initial cost of system Labor requirements - labor availability - labor cost Maintenance requirements	Read: Citrus Irrigation Management, Circular 444, pp. 11-12. Students should refer back to the four types of irrigation and evaluate each system for selection. Evaluation: See Irrigation Exam.

UNIT: CITRUS PRODUCTION

MODULE: IRRIGATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
6. Identify four ways to save energy by water management.	Irrigation to maximize production - increase yields - increase quality - excess irrigation can be detrimental and costly Irrigation by the accounting method - timing efficiency Low volume irrigation - largest water and energy savings - still has problems Weed control - lessens competition for available water Variety selection. - some rootstocks require more water - consider this when planting new trees	Read: Energy Saving Tips for Growing Florida Citrus, FC-48. Water Management. Evaluate local grove management techniques to identify ways to save water and energy.

ENERGY LOSS DUE TO TYPE OF IRRIGATING SYSTEM

Citrus irrigation consumes more energy than any other production and harvesting operation. (See Module 1) An estimated 32% of the total energy expended by growers to produce and harvest the crop goes into irrigation and drainage. The following is a list of how energy is lost pertaining to the irrigation system.

1. Permanent Overhead and Volume Gun:

   - higher uniform volves are found for night irrigation than day irrigation for both systems because of less air movement

   - water distribution is affected by the spacing of sprinklers in permanent overhead systems with closer spacings provided more uniform water distribution

   - evaporational loss of water was higher during day irrigation than night irrigation

   - evaporation losses from the volume gun are less than half that of the permanent overhead in day operation

   - efficiency of overhead sprinkler systems is reduced when such systems are operated in recently planted widely spaced groves (young tree root systems only occupy a small percentage of the total soil volume.)

2. Flood Irrigation:

   - applications in excess of tree need decreases overall efficiency

   - applications in excess of water holding capacities also decrease overall efficiency

3. Low Volume Irrigation:

   - when such systems are run continuously or for long periods, water movement beyond tree root zone results

Also, a big savings of energy would result in a schedule of maintenance for the pumping system. Your cost of energy would be reduced if your pump is operating efficiently. The cost of repairs would be reduced if problems arising in the pumping system were not allowed to continue until the system is inoperatable.

HANDOUT

THE ACCOUNTING METHOD

The approach is called the "water account system". It is operated like an ordinary bank account. It is based on the concept that the moisture in the soil at any given time is a balance between available moisture which is deposited as rainfall or irrigation and that which is withdrawn from evaporation and transpiration. (ET)

The daily water requirement for a specific type of vegetation is very closely related to the daily mean temperature, day length and relative humidity. Mean temperatures and day length values are readily available for specific areas and latitudes. Average daily moisture requirement for Florida citrus is shown in Table 1.

Table 1

Potential Daily Moisture Requirements (ET) of Florida Citrus[1]

Crop	Maximum ET	Minimum ET
	Inches Per Day	
Citrus	0.20	0.08

The usuable soil moisture capacity (in inches), divided by the high average daily requirement (in inches), will give the design irrigation frequency (in days). In the accounting system, daily use represents withdrawals while rainfall and irrigation represent deposits. Irrigation would be applied as necessary to return the soil root zone to field capacity before economic growth retardation occurs. Too large a water application is undesirable, not only from the standpoint of leaching plant foods such as nitrogen, potash, magnesium and boron, but also from the added irrigation cost.

Example:

$$\text{Irrig. Freq. (in days)} = \frac{\text{usuable soil moisture (in.)}}{\text{High Daily ET (in.)}}$$

[1] Irrigate By the Accounting Method, Circular 431, R.E. Choate and D.S. Harrison, 11-10M-77.

Citrus Low Energy Technology Module

Irrigation Exam

1. Identify four types of irrigation available to the citrus producer and their respective efficiency.

   a.

   b.

   c.

   d.

2. Identify three methods to determine soil moisture content.

   a.

   b.

   c.

3. Explain how to use the Accounting Method to determine the need for irrigation.

4. Identify five factors to consider when selecting an irrigation system.

   a.

   b.

   c.

   d.

   e.

5. Identify four ways to save energy by water management.

a.

b.

c.

d.

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES

The student will be able to:
 	
1. Identify the five types of cold protection available to the citrus producer.
	Site selection
	
	- southernly latitude
	- temperature on slopes remain warmer
	- down wind from water bodies
	- use of climatic maps
	
	Floor condition
	
	- bare soil absorbs warm air during the day and releases it at night.
	
	Geometry
	
	- closely planted trees:
	  - decrease wind speeds
	  - have a smaller percentage of their leaves exposed
	
	- on slopes: plant in rows to drain cold air
	
	Pruning
	
	- full leaf during winter months:
	  - reduce wind speeds
	  - decrease cooling rate of twigs and leaves
	  - prune as late as possible in spring
		Read: Passive Freeze Protection Suggestions for Your Orchard, EC-23.
		
		Visit area groves and evaluate the use of their passive cold protection techniques.
		
		Student should write a short paragraph on five types of passive cold protection used in citrus protection.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	Application of fertilizer - avoid late summer and fall, late growth may prevent tree from hardening - but trees must be furnished with sufficient nutrients Herbicide/Pesticide Applications - should be avoided late in season - can cause loss of resistance Variety Selection - plant an early variety in a freeze-suseptable are - varieties vary in their ability to withstand freezing temperature - hardiest varieties should be planted in coldest sites - each cultivar varies in its chill and heat unit requirements	

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
2. Identify four types of intensive cold protection methods with at least four advantages and disadvantages of each.	Heaters -Advantages: - direct radiation provides heat - air immediately around the heater is heated by convection - stack heaters low initial cost, maneuverability, and versatility - compared to stack heaters, centralized pressure fuel systems burning diesel fuel and liquid propane are more fuel efficient and offer considerable labor savings -Disadvantages: - heat is lost if rises above level of trees - need fuel burning efficiency - need pollution reduction - fuel can be lost to spillage, leakage and boiling - high labor requirements for lighting and refueling heaters -Energy saving tips for heaters: - maintain heaters in good working order - have sufficient thermographs or thermometers throughout grove area - large groves can be heated more efficiently than small groves - plot temperature drop vs time throughout the night	Read: Energy Saving Ideas for the Orchard Cold Protection, EC-22. Bring in the four most common types of heaters: spot heater, jumbo cone, return stack and improved Scheu.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	- important to light heaters one to two degrees above the lethal temperature of leaves, blossoms and buds - during initial phase of protection it is possible to stabilize temperatures by lighting every other row of heaters - many small heaters generally provide more efficient heat distribtuion than a few large ones - be familiar with cold areas in your grove so that heaters in those areas can be lit first Wind Machines -Advantages: - minimize labor requirements - permanently located in grove - low operational cost - consumes less fuel/acre protected - requires less fuel storage than heaters -Disadvantages: - rather high capital cost - fails to provide adequate cold protection under all conditions - dependent on inversion of $5^{o}F$ - most effective in low pockets - the increase in temperature is highest near machine	Visit a local grove that has wind machines.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	Overtree Sprinkling -Advantages: - water releases heat when it turns from liquid to ice - uses the least energy - clean and convenient - less labor costs -Disadvantages: - no longer recommended for citrus - improper use can cause more damage than if the trees were left unprotected - higher sprinkling rates are required if wind speeds increase or air temperatures outside area to be protected fall below lethal temperature - water must be supplied constantly to maintain ice water mixture or tissue temperatures may drop to lethal point - excessive water may cause damaging ice build-up on limbs and water log the soil - a grower is committed to more hours of protection with water than a heating system.	Visit a local grove with an overtree sprinkling system. Obtain slides of a freeze in which overtree sprinkling was used for cold protection in a citrus grove.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
	Artificial Fog Most of the heat loss from a grove occurs as radiation to the sky on clear, cold nights. -Advantages: - artificial fog minimize the amount of heat loss through radiation - economical means of cold protection proven in tests and on a trial basis - cost decreases as area to be protected increases - operating cost and energy consumed with this approach is small - energy is required only in pumping water -Disadvantages: - high capital outlay - fifty acres is the minimum economical area of protection for many crops - can only be used with low windspeeds - wind direction must be in the direction of area to be protected.	Visit a local grove that has an artificial fog machine. Student must list four types of methods and at least four advantages and disadvantages of each.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
3. Identify the percent of Florida's Citrus Production Engery used for cold protection.	Cold protection - 21.9%	Read: Citrus Engery Use and Conservation, EI -47. Transparency: "Florida Citrus Production Engery Use 1977-78." (See page 8) Evaluation: Given an emoty piegraph, student must identify the percent of Florida's citrus production engery used for cold protection.
4. Identify the percent of area fuel type and quantity of energy used by heaters, wind machines, water systems and a combination (wind machines/ heaters) for cold proctection in citrus production.	Heaters - 8.5% of area protected - diesel fuel used - approximately 17 million gallons used Wind Machines - 6.3% of area protected - gasoline fuel used - approximately 200 thousand gallons used Water System - 35.2% of area protected - no fuel used - energy is used in pumping water - usually done in advance	Read Handout: "Fuel Requirement Estimates - Cold Protection" (1977-78 Crop Year). Given the table student must complete the area, fuel type and quantity of engery used by heaters, wind machines, water systems and a combination (wind machines/heaters) for cold protection in citrus production.

UNIT: CITRUS PRODUCTION

MODULE: COLD PROTECTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
4. (continued)	Combination (wind machine/heaters) - 1.3% of area protected - diesel and gasoline fuel are used - approximately one million gallons combined of fuel are used	
5. Identify four methods to minimize heating requirements and saving energy.	Combination of methods - heaters and wind machines Select the proper temperature for lighting, heating or starting any system of cold - use climatic data Consider protecting only fruiting surface and letting fruit freeze - no loss to producer if fruit has previously been sold bulk - difference of 24°F - uncertain fuel supplies warrant consideration of this alternative - fruit can still be used for processing if harvested within a week to 10 days Monitor temperatures closely Heat only when absolutely essential	Read: Energy Saving Ideas for Orchard Cold Protection, EC-22. Given freeze circumstances students must identify in paragraph form the energy savings for four methods to minimize requirements. Read Handout: "Freeze Warning". Evaulation: See Cold Protection Exam.

FUEL REQUIREMENT ESTIMATES - COLD PROTECTION (1977-78 CROP YEAR)

PROTECTION	PROJECTED ACERAGE	% OF AREA PROTECTED	UNITS 1/	NIGHT OPERATED 2/	FUEL QUANTITY (GALLONS)	FUEL TYPE
HEATERS 3/	22,989	8.5	804,615	7.0	16,887,213	DIESEL
WIND MACHINES 4/	17,845	6.3	1,785	7.0	197,199	GASOLINE
WATER SYSTEMS 5/ (DAMP SOIL)	103,738	35.2				
COMBINATION: WIND MACHINE HEATERS	3,460	1.3	347 51,900	7.0	35,721 1,068,588	GASOLINE DIESEL

PG 26-45 CITRUS ENERGY SURVEY - USE ESTIMATES AND CONSERVATION

1/ ASSUMING 35 HEATERS/ACRE ALONE, 15/ACRE IN COMBINATION, 1 WIND MACHINE/10ACRES

2/ EQUIPMENT OPERATED 6 HOURS/NIGHT

3/ FUEL CONSUMED - 1 GAL. DIESEL PER HOUR PER HEATER

4/ FUEL CONSUMED - 5 GA. GASOLINE PER HOUR PER MACHINE

5/ PART OF IRRIGATION

FUEL REQUIREMENT ESTIMATES - COLD PROTECTION (1977-78 CROP YEAR)

PROTECTION	% OF AREA PROTECTED	FUEL QUANTITY (GALLONS)	FUEL TYPE
HEATERS			
WIND MACHINES			
WATER SYSTEMS (DAMP SOIL)			
COMBINATION: WIND MACHINE			
HEATERS			

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HANDOUT

FREEZE WARNING

Cold protection required about 22 percent of the engery comsumed for Florida's citrus production in 1977-78. This period was not as cold as the preceding year, but it was colder than the 1978-79 season.

The total fuel requirements for cold protection are enormous and costly. The citrus industry alone can comsume up to $6 million worth of fuel in one night for cold protection. We need to become more aware of the energy usage, cost and savings.

The use of heaters in 1977-78 for cold protection required approximately 17 million gallons of gas at a cost of twenty-two million dollars to the citrus producers in the state of Florida.

When temperatures drop to 24°F for approximately four hours in the citrus intensive region of central Florida, grove owners are encouraged to take precautions against losing their citrus crop.

Using heaters in conjunction with wind machines provides better protection at a lower cost than heaters alone. An acre requiring 35 heaters without wind machines would require only 15 heaters with wind machines. This combination, plus a good air temperature inversion, would permit heaters to be used half of the time reducing fuel costs and increasing heater's life span.

Using climatic data for Bartow, Florida, protecting a grove nine out of ten years at 28°F would require 26 hours of heating per winter. If heating at 24°F instead, the grower would heat only 5 hours using one-fifth as much fuel.

Monitoring temperatures closely reduce wasting fuel, time, money and energy when you don't need cold protection. Mistakes are costly for the grove owner and consumer.

CITRUS MODULE - COLD PROTECTION EXAM

1. Identify five types of cold protection available to the citrus producer.

   a.

   b.

   c.

   d.

   e.

2. Identify four types of intensive cold protection methods with at least four advantages and disadvantages of each

   a. _____

Advantages	Disadvantages
(1)_____	(1)_____
(2)_____	(2)_____
(3)_____	(3)_____
(4)_____	(4)_____

   b. _____

Advantages	Disadvantages
(1)_____	(1)_____
(2)_____	(2)_____
(3)_____	(3)_____
(4)_____	(4)_____

   c. _____

Advantages	Disadvantages
(1)_____	(1)_____
(2)_____	(2)_____
(3)_____	(3)_____
(4)_____	(4)_____

d._____

Advantages	Disadvantages
(1)_____	(1)_____
(2)_____	(2)_____
(3)_____	(3)_____
(4)_____	(4)_____

3. _____ protects 38.2% of citrus which has cold protection. This type uses no energy.

4. _____ protects the least area but costs the most in fuel requirements.

5. Identify four methods to minimize heating requirements and saving energy.

   a.

   b.

   c.

   d.

UNIT: CITRUS PRODUCTION

CITRUS PRODUCTION

MODULE: HARVESTING AND HAULING

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Identify seven ways to save energy when harvesting and hauling citrus fruit.	Picking -mechanical aids -pickers should not use own transportation when a bus or van is provided Harvesting -use diesel engines -proper maintenance of machines -proper inflation of tires -proper loading Hauling -trade in pounds solid of juice instead of hauling fruit -sell to a closer packing house, when considering price consider cost of hauling fruit -unified grading system is needed to accomplish trading	Read Handout: "Picking and Hauling of Citrus Fruit" Have students prepare a report on sitings of wasted energy due to poor picking, harvesting and hauling techniques. Evaluation: See Harvesting Exam.

HANDOUT

PICKING AND HAULING OF CITRUS FRUIT

Picking and loading refers to all activities involved in getting the fruit from the tree to roadside. It has been documented that distance, hauling methods, truck size and other factors affect picking and hauling costs. Also, fruit delivered to processors is hauled differently than fruit delivered to packing houses.

The largest item in the cost of picking citrus is labor. All labor including payroll taxes and workmen's compensation insurance was 82.5% of the total cost of picking and loading oranges. Machine cost has gone up much faster than labor costs and presently cannot compete. With an influx of refugees and immigrants Florida should not experience another labor shortage like the one in 1973. The technology and system is available but it would take time to implement the switch to machinery. Mechanical aids is another viable solution which would increase productivity without increasing energy usuage. Aids such as a movable platform instead of a ladder. But the increase in production has not been enough to justify usuage.

An operation that consumed a large amount of energy was transporting pickers to groves. There was an assumption made from collected data that there is one crew for every 300 acres. Most crews had a van or bus for transportation. Each van or bus might have traveled 20,000 miles per year. It was assumed there are 8,520 picking crews in Florida. If each used a van that was driven 20,000 miles for the picking operation at eight miles per gallon, then 7,102,500 gallons of gasoline was required to haul these crews. This does not include fuel used by pickers driving personal vehicles to the groves, which occurred frequently. When fuel is provided it is a waste to use more fuel.

Harvesting the fruit from tree location to the loading point proved to be energy expensive. The requirement just to operate the equipment used was 3.66 gallons of gasoline per acre on a statewide average. This was for operating "highlifts" or "goats". Energy can be conserved by using diesel fuel, proper maintenance of machines, proper inflation of the tires, and proper loading.

The hauling operation refers to transportation of fruit from the roadside to the processing plant or fresh packing house. For the state, fruit was hauled an average of 34 miles (one-way). Hauling cost for 1978-79 increased 8.4 percent from the previous season. To lessen some of this expense, buyers have begun trading in pounds solid of juice. They can bargain over the phone and save fuel and energy. A unified grading system is needed to standardize the product. Trading will replace the cost to consumer and producer of hauling fruit.

LOW ENERGY TECHNOLOGY IN CITRUS

Evaluation: HARVESTING EXAM

1. Identify two ways to save energy in the picking operation.

   a. _____

   _____

   b. _____

   _____

2. Identify three ways to save energy when harvesting citrus fruits from tree location to roadside.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

3. Identify two ways to save energy when hauling citrus fruit.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____